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National Occupational Analysis

Instrumentation and Control Technician

2013

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National Occupational Analysis

INSTRUMENTATION AND CONTROL TECHNICIAN

2013

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FOREWORD

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this National Occupational Analysis (NOA) as the national standard for the occupation of Instrumentation and Control Technician.

Background

The first National Conference on Apprenticeship in Trades and Industries, held in Ottawa in 1952, recommended that the federal government be requested to cooperate with provincial and territorial apprenticeship committees and officials in preparing analyses of a number of skilled occupations. To this end, Employment and Social Development Canada (ESDC) sponsors a program, under the guidance of the CCDA, to develop a series of NOAs.

The NOAs have the following objectives:

- to describe and group the tasks performed by skilled workers;
- to identify which tasks are performed in every province and territory;
- to develop instruments for use in the preparation of Interprovincial Red Seal Examinations and curricula for training leading to the certification of skilled workers;
- to facilitate the mobility of apprentices and skilled workers in Canada; and,
- to supply employers, employees, associations, industries, training institutions and governments with analyses of occupations.

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This analysis was prepared by the Labour Market Integration Directorate of ESDC. The coordinating, facilitating and processing of this analysis were undertaken by employees of the NOA development team of the Trades and Apprenticeship Division. The host jurisdiction of Alberta also participated in the development of this NOA.

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To facilitate understanding of the occupation, the work performed by tradespersons is divided into the following categories:

Blocks	the largest division within the analysis that is comprised of a distinct set of trade activities
Tasks	distinct actions that describe the activities within a block
Sub-Tasks	distinct actions that describe the activities within a task
Key Competencies	activities that a person should be able to do in order to be called 'competent' in the trade

The analysis also provides the following information:

Trends	changes identified that impact or will impact the trade including work practices, technological advances, and new materials and equipment
Related Components	a list of products, items, materials and other elements relevant to the block
Tools and Equipment	categories of tools and equipment used to perform all tasks in the block; these tools and equipment are listed in Appendix A
Context	information to clarify the intent and meaning of tasks
Required Knowledge	the elements of knowledge that an individual must acquire to adequately perform a task

The appendices located at the end of the analysis are described as follows:

Appendix A — Tools and Equipment	a non-exhaustive list of tools and equipment used in this trade
Appendix B — Glossary	definitions or explanations of selected technical terms used in the analysis
Appendix C — Acronyms	a list of acronyms used in the analysis with their full name
Appendix D — Block and Task Weighting	the block and task percentages submitted by each jurisdiction, and the national averages of these percentages; these national averages determine the number of questions for each block and task in the Interprovincial exam
Appendix E — Pie Chart	a graph which depicts the national percentages of exam questions assigned to blocks
Appendix F — Task Profile Chart	a chart which outlines graphically the blocks, tasks and sub-tasks of this analysis

DEVELOPMENT AND VALIDATION OF ANALYSIS

Development of Analysis

A draft analysis is developed by a committee of industry experts in the field led by a team of facilitators from ESDC. This draft analysis breaks down all the tasks performed in the occupation and describes the knowledge and abilities required for a tradesperson to demonstrate competence in the trade.

Draft Review

The NOA development team then forwards a copy of the analysis and its translation to provincial and territorial authorities for a review of its content and structure. Their recommendations are assessed and incorporated into the analysis.

Validation and Weighting

The analysis is sent to all provinces and territories for validation and weighting. Participating jurisdictions consult with industry to validate and weight the document, examining the blocks, tasks and sub-tasks of the analysis as follows:

BLOCKS	Each jurisdiction assigns a percentage of questions to each block for an examination that would cover the entire trade.
TASKS	Each jurisdiction assigns a percentage of exam questions to each task within a block.
SUB-TASKS	Each jurisdiction indicates, with a YES or NO, whether or not each sub-task is performed by skilled workers within the occupation in its jurisdiction.

The results of this exercise are submitted to the NOA development team who then analyzes the data and incorporates it into the document. The NOA provides the individual jurisdictional validation results as well as the national averages of all responses. The national averages for block and task weighting guide the Interprovincial Red Seal Examination plan for the trade.

This method for the validation of the NOA also identifies common core sub-tasks across Canada for the occupation. If at least 70% of the responding jurisdictions perform a sub-task, it shall be considered common core. Interprovincial Red Seal Examinations are based on the common core sub-tasks identified through this validation process.

Definitions for Validation and Weighting

YES	sub-task performed by qualified workers in the occupation in a specific jurisdiction
NO	sub-task not performed by qualified workers in the occupation in a specific jurisdiction
NV	analysis Not Validated by a province/territory
ND	trade Not Designated in a province/territory
NOT COMMON CORE (NCC)	sub-task, task or block performed by less than 70% of responding jurisdictions; these will not be tested by the Interprovincial Red Seal Examination for the trade
NATIONAL AVERAGE %	average percentage of questions assigned to each block and task in Interprovincial Red Seal Examination for the trade

Provincial/Territorial Abbreviations

NL	Newfoundland and Labrador
NS	Nova Scotia
PE	Prince Edward Island
NB	New Brunswick
QC	Quebec
ON	Ontario
MB	Manitoba
SK	Saskatchewan
AB	Alberta
BC	British Columbia
NT	Northwest Territories
YT	Yukon Territory
NU	Nunavut

ANALYSIS

Safe working procedures and conditions, accident prevention, and the preservation of health are of primary importance to industry in Canada. These responsibilities are shared and require the joint efforts of government, employers and employees. It is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and work environments can be created by controlling the variables and behaviours that may contribute to accidents or injury.

It is generally recognized that safety-conscious attitudes and work practices contribute to a healthy, safe and accident-free work environment.

It is imperative to apply and be familiar with the Occupational Health and Safety (OH&S) Acts and Workplace Hazardous Materials Information System (WHMIS) regulations. As well, it is essential to determine workplace hazards and take measures to protect oneself, co-workers, the public and the environment.

Safety education is an integral part of training in all jurisdictions. As safety is an imperative part of all trades, it is assumed and therefore it is not included as a qualifier of any activities. However, the technical safety tasks and sub-tasks specific to the trade are included in this analysis.

SCOPE OF THE INSTRUMENTATION AND CONTROL TECHNICIAN TRADE

"Instrumentation and Control Technician" is this trade's official Red Seal occupational title approved by the CCDA. This analysis covers tasks performed by instrumentation and control technicians whose occupational title has been identified by some provinces and territories of Canada under the following names:

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
Industrial Instrument Mechanic				✓			✓			✓		✓	
Industrial Instrument Technician								✓					✓
Instrument Technician									✓		✓		
Instrumentation and Control Technician	✓	✓	✓			✓							

Instrumentation and control technicians are knowledgeable in overall plant systems and the interactions of processes. They install and service a variety of systems including safety and security, energy delivery (hydraulic, pneumatic and electrical), communication, and process control systems. They also install and service measuring and indicating instruments to monitor process control variables, monitor the operation of equipment and measure the characteristics of the material within a process. Instrumentation and control technicians work with final control devices such as valves, actuators and positioners to manipulate the process medium. They install and terminate electrical, pneumatic and fluid connections. They also work on network and signal transmission systems such as fibre optic and wireless.

Along with the calibration, repair, adjustment and replacement of components, instrumentation and control technicians inspect and test the operation of instruments and systems to diagnose faults and verify repairs. They establish and optimize process control strategies, and configure related systems such as Programmable Logic Controllers (PLCs), Distributed Control Systems (DCSs), Human Machine Interfaces (HMIs) and Supervisory Control and Data Acquisition (SCADA) systems. Instrumentation and control technicians maintain backups, documentation and software revisions as part of maintaining these computer-based control systems. Scheduled maintenance and the commissioning of systems are also important aspects of the work. Instrumentation and control technicians consult technical documentation, drawings, schematics and manuals. They may assist engineering in plant design, modification and hazard analysis, and work with plant operators to optimize plant controls.

Instrumentation and control technicians use hand, power and electronic tools, test equipment, and material handling equipment. They work on a range of instruments including primary control elements, transmitters, analyzers, sensors, detectors, signal conditioners, recorders, controllers and final control elements. These instruments measure and control variables such as pressure, flow, temperature, level, motion, force and chemical composition.

Instrumentation and control technicians work in various industrial sectors such as pulp and paper/fibre processing; nuclear, thermal and hydro power generation; mining; petrochemical; oil and gas; steel; water treatment; manufacturing; and industrial/commercial instrument servicing.

When performing their duties, instrumentation and control technicians must comply with federal, jurisdictional, industrial and site-specific standards, codes and regulations. They must ensure that all processes operate and are maintained within these set standards, codes and regulations. Keeping up-to-date with advances in technology in industry and the trade is important.

Instrumentation and control technicians can work in hazardous environments where they may be exposed to confined spaces, heights, noise, dust, cold and heat. There may also be risks with working with chemicals, gases, radiation, laser equipment and substances under pressure.

Key attributes for people entering this trade are manual dexterity, attention to detail, strong problem solving skills, communication skills, technological aptitude and mathematical and scientific aptitude.

This analysis recognizes similarities or overlaps with other tradespersons and professionals such as process operators, steamfitters/pipefitters, industrial mechanics (millwrights), electricians and engineers.

With experience, instrumentation and control technicians may act as mentors and trainers to apprentices in the trade. They may also move into supervisory, design, advanced control, training, sales and other related positions.

Computers have become a common tool in the industry, from administrative to diagnostics and everyday maintenance tasks.

There is an increase in the performance of devices adding functionality such as smart maintenance indicators and the generation of internal faults and alarms therefore reducing basic preventative maintenance requirements.

Control systems network technologies and equipment are becoming less proprietary and borrow from IT technology networks. There is an increase in the use of PLCs for process control. PLC and DCS based control systems are increasingly merging in functionality.

Device bus networking and technologies are replacing single end run cabling, bringing down the cost of installation but increasing complexities of control systems. Wireless based networks for monitoring remote locations are reducing cabling requirements. This improves transmission speed, distances and information capacity.

There is a demand to utilize the advances in technology in industry which has found its way into almost all aspects of the trade. With this demand, the process of diagnostics and repair continues to evolve, placing an increased demand on instrumentation and control technicians to follow the pace of these advances. For example, there is a rise in the use of mass flowmeters for process monitoring and custody transfer. A mass flow transmitter replaces several single variable transmitters, reducing instrumentation and cabling requirements. Multiphase flow metering is another emerging technology.

There is a continued increase in industry practices for environmental monitoring driven by governmental regulations. More instrumentation equipment specific to environmental monitoring is now required. The maintenance and reporting of this equipment has become an important part of the technician's duties.

Reliability centered maintenance and process safety management including safety instrumented systems (SISs) are becoming more common in industry.

There is an increased focus on safety which results in industry adopting new practices such as pre-job hazard assessments and mandated development of safe work procedures.

Essential skills are needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change.

Through extensive research, the Government of Canada and other national and international agencies have identified and validated nine essential skills. These skills are used in nearly every occupation and throughout daily life in different ways.

A series of CCDA-endorsed tools have been developed to support apprentices in their training and to be better prepared for a career in the trades. The tools can be used independently or with the assistance of a tradesperson, trainer, employer, teacher or mentor to:

- understand how essential skills are used in the trades;
- learn about individual essential skills strengths and areas for improvement; and
- improve essential skills and increase success in an apprenticeship program.

Tools are available online or for order at: http://www.hrsdc.gc.ca/eng/jobs/les/index.shtml

The application of these skills may be described throughout this document within the competency statements which support each subtask of the trade. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at www.red-seal.ca.

Reading
Instrumentation and control technicians require reading skills to locate and interpret technical information for their trade. These texts include technical articles about new products and industry practices, bulletins from manufacturers and on health and safety, calibration and service guides, incident reports, procedures, manuals and notes.

Document Use
Instrumentation and control technicians locate and interpret information in both print and electronic formats. Types of documents referenced include computer printouts with numeric information, supplier catalogue listings and engineering documentation such as forms, graphs, tables, charts, schematics, assembly diagrams and drawings. They may also create documents such as on-site sketches and detailed schematics, assembly drawings, graphs and charts.

Writing
Writing skills are used by instrumentation and control technicians to create parts lists, maintenance schedules, and inspection reports. Instrumentation and control technicians write procedures for the control and operation of equipment and to troubleshoot faults. They use writing skills when communicating through e-mail and providing status updates in logbooks.

Numeracy

Instrumentation and control technicians must apply measurement and calculation, data analysis and numerical estimation skills to their tasks. Some of these tasks include measuring analyzer malfunctions, calculating flow, calculating volume displacement, monitoring pressure, interpreting deviations on graphs, and comparing values and measurements. Instrumentation and control technicians evaluate sets of data collected from tests and simulations to troubleshoot faults, assess equipment performance and assess the progress of wear.

Oral Communication

In order to coordinate work, instrumentation and control technicians interact with other tradespeople such as steamfitter/pipefitters, welders, machinists, electricians and industrial mechanics (millwrights). They may also discuss systems design and problems with supervisors and engineers, and provide expert advice and opinion. Instrumentation and control technicians also exchange technical repair and troubleshooting information and speak to process operators about equipment and machinery breakdown. At times, they may make formal presentations to explain monitoring procedures or new equipment.

Thinking

Instrumentation and control technicians troubleshoot malfunctions, take corrective measures to avoid potential hazards and decide whether to repair or replace components based on time and cost factors. They plan and organize maintenance schedules, the installation of new machinery and the tradespeople assigned to install the machinery. Instrumentation and control technicians must be able to think quickly and synthesize the information at hand to deal with emergencies such as serious equipment malfunctions that could cause injury, or property and environmental damage.

Digital Technology

Instrumentation and control technicians install and service programmable process control systems such as PLCs, DCSs, SCADA systems and HMIs. They may use hand-held digital devices to configure settings and to access data such as measurement and operational values. Instrumentation and control technicians may use word processing software, databases, spreadsheets, communication software and devices, the Internet, and computer-assisted design (CAD), manufacturing or machining software depending on the task at hand.

Working with Others

Even though instrumentation and control technicians often work alone, they may also work with other tradespeople, professionals and process operators. Instrumentation and control technicians work with process operators to ensure instrumentation is properly maintained and emergencies are handled quickly. They work with other tradespeople to perform functions such as testing transmitters or controllers, and installing control valves. Instrumentation and control technicians sometimes work as part of a crew, for example when running wires. In doing so they may fill the role of either team member or team leader on project teams.

Continuous Learning

Instrumentation and control technicians may attend training in areas that are new or continually evolving in the trade such as safety, digital technology and more sophisticated computer applications relating to process control. They may attend technical courses offered by suppliers' representatives covering new equipment, as well as team leadership/communication seminars. Continuous learning also occurs through the reading of technical literature and by troubleshooting.

Trends

The expectations for safe work practices continue to increase with more regulations and greater enforcement.

Environmental regulations are increasing requirements for reliable, auditable and accurate documentation. Environmental accountability leads to larger needs in metering, reporting and traceability in industrial activities.

Related Components

All components apply.

Tools and Equipment

See Appendix A.

Task 1 Performs safety-related functions.

Context

Instrumentation and control technicians must ensure a safe work environment by complying with safety regulations and procedures. They use personal protective equipment (PPE) and safety equipment to ensure their safety and that of others. They also use de-energizing, lock-out and tag-out procedures to ensure safe conditions when working on equipment.

Required Knowledge

K 1	workers' rights and responsibilities
K 2	workplace safety and health regulations such as WHMIS, Transportation of Dangerous Goods (TDG) and jurisdictional health and safety acts
K 3	hazardous area classifications
K 4	company safety policies and procedures
K 5	training requirements such as fall protection, confined space entry, and hoisting and rigging
K 6	hazards such as nuclear devices, pressures, temperatures, chemicals and voltages
K 7	fire safety codes and procedures

K 8	work permit and safe work analysis requirements such as job safety hazard assessment (JSHA), safe work procedures, and lock-out and tag-out procedures
K 9	housekeeping practices
K 10	emergency procedures and location of safety equipment
K 11	disposal and recycling procedures
K 12	PPE such as safety glasses, safety boots, gloves, coveralls and face shields
K 13	safety equipment such as first aid kits, fire extinguishers and eye wash stations
K 14	PPE and safety equipment operation and limitations
K 15	maintenance schedules and certification requirements of PPE and safety equipment
K 16	procedures for shutting down processes
K 17	procedures for isolating equipment from energy sources
K 18	procedures for de-energizing equipment such as electrical, electronic, mechanical, hydraulic, pneumatic and nuclear
K 19	procedures for energizing equipment such as electrical, electronic, mechanical, hydraulic, pneumatic and nuclear

---

Sub-task

A-1.01 Maintains safe work environment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.01.01	follow specified safety procedures such as fall arrest, JSHA and confined space procedures
A-1.01.02	identify hazards such as high voltage, rotating equipment, nuclear radiation, hazardous gases, environmental extremes, working at heights and noisy locations
A-1.01.03	maintain a clean and tidy work site to avoid injuries to self and others
A-1.01.04	coordinate tasks with other workers to avoid injury to self and others
A-1.01.05	use barricades and signage to identify hazards in work areas
A-1.01.06	handle hazardous materials in accordance with WHMIS procedures such as disposal, labelling and using PPE

A-1.01.07	participate in safety meetings and discussions to ensure that information is recorded and distributed to all team members
A-1.01.08	recognize and report unsafe conditions and personal injury hazards so that they may be rectified
A-1.01.09	use safety mechanisms such as double-block-and-bleed, and temporary safety protection

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Sub-task

A-1.02 Uses personal protective equipment (PPE) and safety equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.02.01	select and wear PPE appropriate for task as identified by site policies, jurisdictional regulations and WHMIS
A-1.02.02	inspect PPE for appropriate fit, expiration date and damage such as excessively worn boots and cracked safety glasses
A-1.02.03	locate and use safety equipment such as fire extinguishers, eye wash stations and first aid kits
A-1.02.04	store PPE and safety equipment according to manufacturers' recommendations
A-1.02.05	test, recertify or replace PPE and safety equipment such as safety harnesses, hard hats and lanyards according to jurisdictional regulations, company policies and manufacturers' recommendations

Sub-task

A-1.03 Performs de-energizing, lock-out and tag-out procedures.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.03.01	identify sources of potential energy such as suspended weight, trapped pressure, electrical potential and radiation sources
A-1.03.02	select isolation points such as valves, brakes and motor control center (MCC) to ensure that energy cannot be added to the system
A-1.03.03	de-energize system using methods such as relieving pressure, applying grounds and releasing brakes
A-1.03.04	perform lock-out according to company and jurisdictional regulations and legislation
A-1.03.05	document equipment lock-out specifics according to jurisdictional regulations

Task 2 Organizes work.

Context

Instrumentation and control technicians organize work effectively using tools and procedures to perform their work. They interpret and update drawing schematics and documentation to access information required for their work. Instrumentation and control technicians plan and coordinate their tasks with other trades and services when required. They also ensure work site, tools and equipment are prepared prior to performing tasks.

Required Knowledge

K 1	symbols and conventions used in diagrams, schematics and drawings such as ISA standards
K 2	metric and imperial systems
K 3	workplace safety and health regulations such as WHMIS, TDG and jurisdictional health and safety acts
K 4	pertinent standards and codes such as ISA standards, Canadian Standards Association (CSA) and Canadian Electrical Code (CEC)
K 5	regulations related to environment and measurement

K 6	types of documentation such as calibration sheets, data sheets and work orders
K 7	maintenance practices such as preventative, predictive and reliability centered programs
K 8	management of change (facility change management) procedures
K 9	trade terminology
K 10	verbal and written communication
K 11	task requirements such as personnel and job plan
K 12	trade equipment and parts
K 13	forms such as bill of materials, purchase orders and material requisitions

---

Sub-task

A-2.01 **Uses diagrams, drawings and schematics.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.01.01	identify symbols and interpret diagrams, drawings and schematics
A-2.01.02	apply symbols, diagrams, drawings and schematics to applications
A-2.01.03	create, modify and update diagrams, drawings, schematics and other documentation according to industry and company standards

---

Sub-task

A-2.02 **Plans tasks.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.02.01	schedule tasks according to operations, personnel availability, tools and equipment
A-2.02.02	select required PPE, safety equipment, tools, equipment, materials, parts and personnel
A-2.02.03	coordinate tasks with other trades

A-2.02.04	coordinate with operations for process equipment availability and safety
A-2.02.05	apply management of change (facility change management) procedures
A-2.02.06	identify potential sources of energy
A-2.02.07	identify inventory requirements according to factors such as criticality, operational needs and manufacturers' recommendations
A-2.02.08	prepare work site by performing activities such as hazard assessment and setting up barricades

Task 3 — Performs routine trade activities.

Context

These tasks are performed across the trade. Instrumentation and control technicians perform routine trade activities using procedures, tools and equipment in a safe, efficient and effective manner. Documentation and reporting of maintenance activities is an essential part of this trade. These activities can affect the safety, productivity, efficiency and regulatory compliance of their work.

Required Knowledge

K 1	types of calibration and test equipment such as multimeters, pressure calibrators and hand-held communicators
K 2	types of configuration equipment such as highway addressable remote transducer (HART) communicators, computers and associated software
K 3	calibration, configuration and test equipment operating procedures and limitations
K 4	maintenance schedule and certification requirements of calibration, configuration and test equipment
K 5	types of hand tools
K 6	hand tool operating procedures and limitations
K 7	portable and stationary power tool operating procedures and limitations
K 8	types and functions of rigging equipment such as belts, ropes, cables and slings
K 9	operating procedures for hoisting and lifting devices
K 10	hoisting and lifting capacities
K 11	material handling equipment including pallet jacks, forklifts, stationary cranes and rigging

Sub-task

A-3.01 Maintains calibration, configuration and test equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.01.01	inspect calibration and test equipment
A-3.01.02	inspect and verify functionality of configuration equipment
A-3.01.03	confirm versions of software and firmware and perform updates
A-3.01.04	recertify calibration and test equipment and devices according to manufacturers' recommendations and regulations
A-3.01.05	calibrate test and calibration equipment to known and traceable standards
A-3.01.06	store calibration, configuration and test equipment according to manufacturers' recommendations
A-3.01.07	document maintenance and certification of calibration, configuration and test equipment

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Sub-task

A-3.02 Maintains tools.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.02.01	store tools in a suitable location to ensure they are in good operating condition
A-3.02.02	inspect hand tools for damage
A-3.02.03	lubricate hand tools such as hydraulic cutters and threading tools to ensure proper operation
A-3.02.04	clean tools after use to ensure operational integrity
A-3.02.05	replace hand tool parts such as cutting blades and hacksaw blades
A-3.02.06	check tool batteries and chargers to ensure they are in good condition and batteries are fully charged

A-3.02.07	clean and inspect power tools for unsafe conditions such as missing, worn and damaged parts, defective or missing protection guards and frayed electrical cords
A-3.02.08	replace power tool components such as drill bits and cutting discs
A-3.02.09	repair defective components of power tools

Sub-task

A-3.03 Maintains documentation.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.03.01	update calibration sheets according to maintenance procedures
A-3.03.02	update and develop maintenance procedures to reflect equipment changes
A-3.03.03	create backup databases of equipment configuration and software according to maintenance procedures
A-3.03.04	maintain and update maintenance records and operation manuals
A-3.03.05	provide condition and assessment reports of equipment to supervisors
A-3.03.06	use forms and data sheets to create service reports
A-3.03.07	file and update regulatory documentation
A-3.03.08	use asset management systems such as work orders, preventative maintenance programs and instrument databases

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Sub-task

A-3.04 Operates material handling equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	no	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.04.01	identify weight of lift and operating capacity of available equipment
A-3.04.02	select material handling equipment according to type of lift and weight
A-3.04.03	identify regulatory and workplace policy limitations to determine what rigging and hoisting operations need to be done by other qualified personnel

A-3.04.04	inspect material handling equipment for defects and expiration dates
A-3.04.05	identify potential hazards such as pinch points, load instability, obstructions and overhead power lines
A-3.04.06	isolate work area prior to lift using safety equipment such as barricades and warning lights
A-3.04.07	store equipment in suitable locations

Trends

Due to the availability of more computing power, process devices have become more sophisticated and have more functionality and diagnostic capabilities integral to the device. In some cases, new technologies such as radars, lasers and clamp-on-meters allow for non-contact process measurements.

There is a trend towards the use of more wireless devices. The use of standardized digital bus communication enables process devices to broadcast more data, do self-diagnostics and control processes at the device level.

Related Components (including, but not limited to)

Pressure measuring devices: pressure gauges, manometers, electronic and pneumatic pressure transmitters, pressure switches.

Temperature measuring devices: thermometers (electronic, infrared, mechanical), thermistors, thermocouples, capillary tubes, resistive thermal devices (RTDs), pyrometers, temperature switches.

Level measuring devices: sight glasses, mechanical level indicators, pneumatic level measuring devices, radar, electronic level measuring devices, level switches.

Flow measuring devices: primary elements (annubars, orifice plates, venturi tubes, pitot tubes, flow nozzles, flumes, weirs, wedge meters, cones), flowmeters (turbine, shedding vortex, magnetic, ultrasonic), thermal mass flow, flow switches.

Motion, speed, position and vibration measuring devices: probes, amplifiers, proximeters, accelerometers, switches.

Mass and density measuring devices: strain gauges, load cells, scales, paddles/blades, nuclear devices, optical devices, displacers.

Consistency measuring devices: blades, rotary paddles, radar, microwave, optical devices.

Other components: indicators, recorders, controllers, seals and gaskets, fittings, brackets, fasteners, piping, wiring, valves.

Process analyzers: water treatment analyzers (pH, conductivity, dissolved oxygen (DO), turbidity, oxidation reduction potential (ORP) concentration), oil and gas analyzers (chromatograph, spectrometers), environmental analyzers (noise, NO_x, CO_2, H_2S, NH_3, SO_2, and other greenhouse gases).

Multiple variable computing devices: temperature and pressure differential, flow computers, level compensators.

Indicating devices: panel meters, pressure/temperature gauges, sight glasses.

Tools and Equipment

See Appendix A.

Task 4 — Installs and services pressure, temperature, level and flow devices.

Context

These measuring devices are used to monitor and control various processes and equipment.

Instrumentation and control technicians install, maintain, diagnose and repair these devices to optimize process control systems. Some devices are used as indicators to visually display process variables.

Required Knowledge

K 1	types of pressure and vacuum measuring devices such as pneumatic, electronic and mechanical
K 2	types of level measuring devices such as differential pressure (DP) transmitter, ultrasonic, radar and float switches (mechanical)
K 3	types of flow measuring devices such as vortex, thermal mass and ultrasonic
K 4	types of temperature measuring devices such as thermocouples, RTD, filled thermal systems and pyrometers
K 5	types of indicating devices such as chart recorders, digital display and gauges
K 6	types of pressure scales such as absolute, differential, gauge and barometric
K 7	temperature scales such as Kelvin, Fahrenheit and Celsius
K 8	types of connections such as piping, tubing and wiring
K 9	primary elements such as orifice plates, turbines and coriolis tubes
K 10	pressure, level and flow calibration instruments such as pressure calibrators, dead weight testers and multimeters
K 11	temperature calibration instruments such as multimeters, temperature baths, dry block calibrators and infrared thermometers
K 12	accuracy and limitations of calibration instruments
K 13	required calibrating parameters of measuring devices such as zero, span, range, repeatability, specific gravity and accuracy
K 14	calibration methods as required by the measuring device
K 15	interaction of various loops
K 16	measuring device operation
K 17	repair/replacement methods

K 18	root cause diagnostics and analysis
K 19	maintenance procedures, documentation and schedules

Sub-task

B-4.01 **Installs pressure, temperature, level and flow devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.01.01	select and use tools and equipment according to type of device
B-4.01.02	select device according to process application, environment and engineered designs
B-4.01.03	select mounting location and mount device according to engineered designs and manufacturers' specifications
B-4.01.04	modify enclosures and panels to hold devices and indicators
B-4.01.05	connect device to the process using methods such as tubing, in-line installation and thermowell according to engineered designs
B-4.01.06	terminate wiring to devices according to engineered designs and manufacturers' specifications
B-4.01.07	configure and calibrate devices according to manufacturers' instructions, process requirements and data sheets
B-4.01.08	verify operation of device within specified parameters by using test equipment and procedures
B-4.01.09	back up and document configuration and calibration settings for future data recovery

Sub-task

B-4.02 **Maintains pressure, temperature, level and flow devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.02.01	perform inspection to detect abnormalities such as leaks, loose connections and corrosion
B-4.02.02	perform function check of devices to confirm proper operation
B-4.02.03	clear sensing lines and sensing taps of the devices by isolating, equalizing or blowing down, to ensure lines are not plugged
B-4.02.04	clean devices using materials such as solvents, fine wire, abrasives and contact cleaners
B-4.02.05	verify calibration of devices according to maintenance specifications
B-4.02.06	calibrate device before returning to service

Sub-task

B-4.03 **Diagnoses pressure, temperature, level and flow devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.03.01	select and use diagnostic tools and equipment such as software, hand-held configurators and calibration equipment
B-4.03.02	perform inspection to detect faults such as leaks, physical damage and poor wiring connections
B-4.03.03	perform function check of device to isolate problems such as plugged sensing line and inadequate power
B-4.03.04	perform as-found calibration check
B-4.03.05	determine probable root cause and location of faults, and identify required repairs

Sub-task

B-4.04 Repairs pressure, temperature, level and flow devices.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.04.01	select and use tools and equipment such as digital multimeters, pressure calibrators and test gauges
B-4.04.02	select replacement components required according to codes and manufacturers' specifications
B-4.04.03	replace components such as sensor boards, liquid crystal displays (LCDs) and thermocouples
B-4.04.04	clear plugged lines using pressurized liquids or air
B-4.04.05	inspect and clean process-wetted components where device contacts the process
B-4.04.06	calibrate device according to manufacturers' specifications

Task 5 Installs and services motion, speed, position and vibration devices.

Context These devices sense motion, speed, position and vibration to monitor the operation of equipment. Instrumentation and control technicians install, maintain, diagnose and repair these devices to protect the integrity of equipment and to control equipment and processes.

Required Knowledge

K 1	motion and position/displacement devices such as torque switches, proximity switches, proximity probes and analog position sensors
K 2	speed devices such as tachometers, strobes and proximeters
K 3	vibration devices such as probes and proximeters
K 4	indicating devices such as chart recorders, digital displays and gauges
K 5	motion, speed, position and vibration calibration instruments such as strobe lights, multimeters and tachometers
K 6	manufacturers' specifications and recommendations

K 7	required calibrating of measuring parameters such as zero, span, range and accuracy
K 8	interaction of various loops
K 9	principles of operation and laws of physics such as speed and velocity
K 10	device operation
K 11	materials such as solvents and contact cleaners
K 12	maintenance procedures, documentation and schedules
K 13	root cause diagnostics
K 14	repair/replacement methods

Sub-task

B-5.01 **Installs motion, speed, position and vibration devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-5.01.01	select and use tools and equipment such as mini-wrenches and feeler gauges according to type of device
B-5.01.02	select device according to process application, environment and engineered designs
B-5.01.03	select cable according to manufacturers' specifications and engineered designs
B-5.01.04	select mounting location and hardware according to manufacturers' specifications and engineered designs
B-5.01.05	mount device using methods such as bolting, welding and threading
B-5.01.06	terminate wiring to devices according to manufacturers' specifications and engineered designs
B-5.01.07	configure and calibrate devices according to manufacturers' instructions to match sensors to receivers
B-5.01.08	verify operation of device within specified parameters by using test equipment and procedures
B-5.01.09	back up and document configuration and calibration settings for future data recovery

Sub-task

B-5.02 **Maintains motion, speed, position and vibration devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-5.02.01	perform inspection to detect abnormalities such as dirt, loose connections and corrosion
B-5.02.02	perform function check of device to confirm proper operation
B-5.02.03	clean components such as optical lenses and probe faces using materials such as solvents, abrasives and contact cleaners
B-5.02.04	verify calibration of devices according to maintenance specifications
B-5.02.05	calibrate device before returning to service

Sub-task

B-5.03 **Diagnoses motion, speed, position and vibration devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-5.03.01	select and use diagnostic tools and equipment such as oscilloscopes, multimeters and hand-held configurators
B-5.03.02	perform inspection to detect faults such as misalignment, physical damage and poor electrical connections
B-5.03.03	perform function check of device to isolate problems such as dirty optics, faulty sensors and inadequate power
B-5.03.04	determine probable root cause and location of faults and identify required repairs

Sub-task

B-5.04 **Repairs motion, speed, position and vibration devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-5.04.01	select and use tools and equipment such as multimeters, feeler gauges and tachometers
B-5.04.02	select replacement components required according to codes and manufacturers' specifications
B-5.04.03	remove and replace components such as sensors, sensor boards, reflectors and transmitters
B-5.04.04	inspect and clean components such as reflectors and lenses
B-5.04.05	calibrate device according to manufacturers' specifications

Task 6 Installs and services mass, density and consistency devices.

Context These devices measure the characteristics of the material within the process. These devices are more complex and specialized and are tailored to match the process. Instrumentation and control technicians install, maintain, diagnose and repair these devices to control and maintain product quality.

Required Knowledge

K 1	types of mass devices such as load cells, scales and strain gauges
K 2	types of density devices such as u-tubes, displacers, nuclear gauges and refractometers
K 3	radiation safety practices
K 4	types of consistency devices such as optical, rotary, blade, paddle and microwave
K 5	types of indicating devices such as chart recorders, digital displays and gauges
K 6	types of connections such as piping and wiring

K 7	factors affecting system performance such as temperature, vibration and pressure
K 8	calibration instruments such as multimeters, refractometers, radiation survey meters and calibrated standards
K 9	accuracy of calibration equipment
K 10	required calibrating measuring parameters such as zero, span, range, repeatability, accuracy and specific gravity
K 11	calibration methods as required by the measuring device
K 12	interaction of various loops
K 13	measuring device operation
K 14	repair/replacement methods
K 15	root cause diagnostics
K 16	maintenance procedures, documentation and schedules

Sub-task

B-6.01 **Installs mass, density and consistency devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-6.01.01	select and use tools and equipment according to type of device
B-6.01.02	select device according to process application, environment and engineered designs
B-6.01.03	select mounting location and hardware according to engineered designs and manufacturers' specifications
B-6.01.04	mount device and connect to the process using methods such as bolting, piping and tubing according to engineered designs
B-6.01.05	terminate wiring to devices according to manufacturers' specifications and engineered designs
B-6.01.06	configure and calibrate devices according to manufacturers' instructions, process requirements and data sheets
B-6.01.07	verify operation of device within specified parameters by using test equipment and procedures
B-6.01.08	back up and document configuration and calibration settings for future data recovery

Sub-task

B-6.02 **Maintains mass, density and consistency devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-6.02.01	perform inspection to detect abnormalities such as leaks, loose connections and corrosion
B-6.02.02	perform function check of device to confirm proper operation
B-6.02.03	clean devices using materials such as solvents, fine wire, abrasives and contact cleaners according to manufacturers' specifications
B-6.02.04	verify calibration of devices according to maintenance procedures
B-6.02.05	calibrate before returning to service

Sub-task

B-6.03 **Diagnoses mass, density and consistency devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-6.03.01	select and use diagnostic tools and equipment such as multimeters, software, hand-held configurators and test equipment
B-6.03.02	perform inspection to detect faults such as leaks, misalignment, physical damage and poor electrical connections
B-6.03.03	check function of device to isolate problems such as dirty lenses, faulty sensors and inadequate power
B-6.03.04	perform as-found calibration check
B-6.03.05	determine probable root cause and location of faults and identify required repairs

Sub-task

B-6.04 **Repairs mass, density and consistency devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-6.04.01	select and use tools and equipment such as multimeters and test weights
B-6.04.02	replace components such as sensors and sensor boards
B-6.04.03	inspect and clean components such as reflectors and lenses
B-6.04.04	rebuild devices such as rotary consistency transmitters and mechanical belt scales to replace worn components
B-6.04.05	calibrate device according to manufacturers' specifications

Task 7 Installs and services process analyzers.

Context

Process analyzers are used to measure and verify that processes are working correctly and following quality control and regulatory standards. Instrumentation and control technicians must be able to install, maintain, diagnose and repair process analyzers to maintain process quality and to protect the environment and personnel.

Required Knowledge

K 1	process analyzers such as pH, conductivity, turbidity and ORP
K 2	quality control analyzers such as chromatographs, spectrometers and pulp quality analyzers
K 3	environmental emission analyzers such as for noise, hazardous gases and greenhouse gases
K 4	types of connections such as piping, wiring and flange-mounted
K 5	operating parameters such as sampling time, lag time and measurement limitations
K 6	required installation conditions such as ambient temperature and cleanliness
K 7	sampling systems, conditioners and methods
K 8	calibration instruments such as lab instruments, multimeters and software
K 9	required calibration parameters of analyzers

K 10	calibration material such as inert gases, standard gases, water and oil
K 11	accuracy and repeatability limitations of the analyzer
K 12	calibration methods as required by the analyzer
K 13	interaction of various loops
K 14	interaction of analyzer to process
K 15	possible contamination of analyzers
K 16	maintenance materials
K 17	theory of analyzer operation
K 18	jurisdictional regulations and licensing requirements
K 19	repair/replace methods
K 20	root cause diagnostics
K 21	maintenance procedures, documentation and schedules

Sub-task

B-7.01 **Installs process analyzers.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-7.01.01	select and use tools and equipment such as mounting jigs and calibration samples according to type of device
B-7.01.02	select analyzers according to process application, environmental conditions, manufacturers' specifications and engineered designs
B-7.01.03	select mounting location and hardware according to engineered designs and manufacturers' specifications
B-7.01.04	mount devices and connect to the process using methods such as in-line and tubing according to manufacturers' instructions and engineered designs
B-7.01.05	terminate wiring to devices according to manufacturers' specifications
B-7.01.06	configure and calibrate analyzer and indicating devices according to manufacturers' instructions, process requirements and data sheets
B-7.01.07	install sampling systems and conditioners

B-7.01.08	verify operation of analyzer and sampling system within specified parameters by using known standards, sampling routines and procedures
B-7.01.09	back up and document configuration and calibration settings for future data recovery

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Sub-task

B-7.02 Maintains process analyzers.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-7.02.01	perform inspection to detect abnormalities such as leaks, incorrect sample flow and corrosion
B-7.02.02	check function of analyzer and sampling system to confirm proper operation
B-7.02.03	clean devices using materials such as solvents, cleaning solutions and brushes
B-7.02.04	clear sample lines by flushing using materials such as air and steam
B-7.02.05	verify calibration of devices according to maintenance procedures
B-7.02.06	calibrate before returning to service

Sub-task

B-7.03 Diagnoses process analyzers.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-7.03.01	select and use diagnostic tools and equipment such as multimeters, software, internal diagnostics and portable analyzers
B-7.03.02	perform inspection to detect errors such as leaks, dirty probes, physical damage and faulty electrical connections
B-7.03.03	check function of process analyzer to isolate problems such as dirty optics, faulty sensors and inadequate power
B-7.03.04	perform as-found calibration check

B-7.03.05	select and use materials such as reference samples and cleaning supplies
B-7.03.06	clean components such as sensors and optics prior to diagnosis
B-7.03.07	determine probable root cause and location of faults and identify required repairs

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Sub-task

B-7.04 **Repairs process analyzers.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-7.04.01	select and use tools and equipment such as multimeters and oscilloscopes
B-7.04.02	replace components such as chopper motors, light sources, sensors and sensor boards
B-7.04.03	clean components such as sensors and internal tubing
B-7.04.04	rebuild devices such as regulators and solenoids
B-7.04.05	repair sampling system faults such as plugged sampling lines, faulty solenoids, filters, valves and regulators
B-7.04.06	verify operation and calibration before returning to service

Task 8 Installs and services multiple variable computing devices.

Context

Multiple variable computing devices are stand-alone systems or are integral to measuring devices, SCADA and control systems. They bring in multiple inputs and use these to perform calculations that compensate for variables such as temperature and pressure when calculating flow or level. There are some devices including flow computers that have many configuration parameters such as product composition and primary flow element specifications.

Instrumentation and control technicians must be able to install, maintain, diagnose and repair multiple variable computing devices to provide accurate flow measurements where a higher degree of accuracy is required.

Required Knowledge

K 1	types and applications of multiple variable computing devices such as flow computers, compensated level and flow measurement
K 2	operational theory of multiple variable computing devices
K 3	operating parameters and configurations
K 4	required installation conditions such as ambient temperature and location
K 5	pressure and temperature calibration equipment such as pressure calibrators, multimeters and software
K 6	accuracy and repeatability limitations of multiple variable computing devices
K 7	calibration methods as required by the multiple variable computing devices
K 8	accuracy of calibration instruments
K 9	required configuration parameters of multiple variable computing devices as required by application and engineered designs
K 10	interaction of various loops
K 11	jurisdictional requirements and accepted engineered standards
K 12	repair/replacement methods
K 13	compensation algorithms combining pressure, temperature, flow and level
K 14	maintenance procedures, documentation and schedules
K 15	root cause diagnostics

Sub-task

B-8.01 **Installs multiple variable computing devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-8.01.01	select and use tools and equipment according to type of device
B-8.01.02	select multiple variable computing devices according to process applications, environmental conditions, engineered designs and manufacturers' specifications
B-8.01.03	select mounting location and hardware according to engineered designs and manufacturers' specifications
B-8.01.04	terminate wiring to multiple variable computing devices according to manufacturers' specifications and engineered designs
B-8.01.05	configure and calibrate multiple variable computing devices according to manufacturers' instructions, application and data sheets
B-8.01.06	verify operation of multiple variable computing devices within specified parameters by using test equipment and procedures
B-8.01.07	back up and document configuration and calibration settings for future data recovery and regulatory requirements

Sub-task

B-8.02 Maintains multiple variable computing devices.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-8.02.01	calibrate multiple variable computing devices during routine maintenance according to manufacturers' instructions, regulatory requirements, process requirements and data sheets
B-8.02.02	upgrade software and firmware for reasons such as avoiding obsolescence, achieving optimal equipment efficiency and accuracy, or meeting jurisdictional standards
B-8.02.03	configure multiple variable computing devices according to applicable engineering and jurisdictional standards
B-8.02.04	document configurations and calibrations to comply with regulatory requirements and to facilitate maintenance activities

Sub-task

B-8.03 Diagnoses multiple variable computing devices.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-8.03.01	select and use diagnostic tools and equipment such as multimeters, software, internal diagnostic tools and hand-held configurators
B-8.03.02	perform inspection to detect errors such as faulty electrical connections, condition of the primary element, and leaks
B-8.03.03	check function of multiple variable computing device to identify problems such as loss of power and communication
B-8.03.04	perform as-found calibration check
B-8.03.05	determine probable root cause and location of faults and identify required repairs

Sub-task

B-8.04 **Repairs multiple variable computing devices.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-8.04.01	select and use tools and equipment such as configurators and software
B-8.04.02	replace components such as circuit boards, power supplies and displays
B-8.04.03	confirm restored configurations
B-8.04.04	verify calibration of multiple input signals according to manufacturers' specifications
B-8.04.05	verify operation and calibration before returning to service

BLOCK C SAFETY AND SECURITY SYSTEMS AND DEVICES

Trends

Due to safety awareness, there is an increase in the use of personal, property and environmental protection equipment as well as security systems.

Safety Instrumented Systems (SISs) are becoming more commonplace because of health, safety and environmental considerations.

Related Components (including, but not limited to)

Safety systems: gas (infrared, electro-chemical cells and catalytic bead), flame (ultraviolet and infrared), heat (thermal pencils and heat sensors), smoke (ionic and particle detectors), spill detection, water quality.

Personal protection devices: portable gas detectors, dosimeters.

Security systems: intruder alerts, remote monitoring, cameras, motion sensors, access systems.

SISs: valves, transmitters, controllers, switches.

Tools and Equipment

See Appendix A.

Specialized equipment: calibration gases, standard samples, software, leak detectors, stop watches.

Task 9 Installs and services safety systems and devices.

Context

Safety systems and devices are used to detect and react to hazards such as gas leaks, fires and spills. Reactions may range from alarms to plant shutdowns and evacuations. The proper installation, calibration and maintenance of these systems are imperative to the safety of the personnel, process operation, equipment and environment.

Required Knowledge

K 1	types of gas detection equipment such as infrared and electrolytic
K 2	types of flame detection equipment such as ultraviolet and infrared
K 3	types of heat detection equipment such as thermal pencils and heat sensors
K 4	types of smoke detection equipment such as ionic and particle detectors
K 5	types of leak detection equipment such as oil in water and oil on water
K 6	types of emission monitoring equipment for conditions such as effluent pH, stack emissions and turbidity of water

K 7	hazardous gases such as chlorine, H_2S and methane, and impact on area hazard classification
K 8	types of personal protection devices such as portable gas detectors, breathing air systems and dosimeters
K 9	acceptable limits according to codes for conditions such as oxygen levels, H_2S levels, radiation levels and water quality
K 10	shutdown procedures, actions and implications
K 11	calibration instruments such as multimeters and configuration software
K 12	certification requirements for calibration equipment
K 13	traceable process standards used in calibration and tests
K 14	required calibrating parameters of safety systems
K 15	maintenance materials such as calibration gases and filters
K 16	accuracy limitations of safety systems
K 17	specific calibration methods required for safety systems
K 18	interaction between safety systems and processes
K 19	maintenance procedures, documentation and schedules
K 20	repair/replacement methods
K 21	root cause diagnostics
K 22	safety system operation and testing requirements/procedures

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Sub-task

C-9.01 Installs safety systems and devices.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-9.01.01	identify hazard or emission to be detected
C-9.01.02	determine location for the detection system and devices according to manufacturers' instructions, and industry standards and codes
C-9.01.03	select and use tools and equipment
C-9.01.04	select safety system for process applications, industry standards and codes
C-9.01.05	select and mount device according to manufacturers' instructions and industry standards and codes
C-9.01.06	configure system according to codes and manufacturers' specifications

C-9.01.07	calibrate by using standard samples to verify system and devices
C-9.01.08	verify operation of safety systems and devices are within specified parameters by using test equipment and procedures
C-9.01.09	back up and document configuration and calibration settings for future data recovery

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Sub-task

C-9.02 Maintains safety systems and devices.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-9.02.01	select and use test equipment and materials such as ultraviolet/infrared (UV/IR) source, calibration gases, filters and smoke generators to verify protection system or device
C-9.02.02	verify systems according to jurisdictional regulations and manufacturers' specifications for proper operation
C-9.02.03	verify PPE according to jurisdictional regulations and manufacturers' specifications for proper operation using methods such as bump testing and calibrating portable gas detectors
C-9.02.04	calibrate safety system components and devices according to manufacturers' instructions, testing and maintenance schedule, process requirements and data sheets
C-9.02.05	perform routine function testing of entire safety loops

Sub-task

C-9.03 Diagnoses safety systems and devices.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-9.03.01	select and use test equipment and materials such as calibration gases, smoke generators, multimeters and colorimeters
C-9.03.02	verify operation of safety systems and devices are within specified parameters by using test equipment, documentation and procedures
C-9.03.03	refer to maintenance documentation, manufacturers' specifications and historical data to assist in root cause analysis
C-9.03.04	analyze process information such as trends and operator logs
C-9.03.05	perform as-found calibration check
C-9.03.06	identify probable root cause and location of faults
C-9.03.07	determine steps required to address deficiencies based on results of root cause analysis such as replacement of components

Sub-task

C-9.04 Repairs safety systems and devices.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-9.04.01	select and use tools, equipment and materials such as multimeters, calibration gases and smoke generators
C-9.04.02	select replacement components required according to codes and manufacturers' specifications
C-9.04.03	replace faulty components according to manufacturers' specifications and procedures
C-9.04.04	calibrate and verify operation of safety systems and devices within specified parameters by using test equipment and procedures

Task 10 — Installs and services facility security systems. (NOT COMMON CORE)

Context

Security systems are used to monitor and alarm security conditions such as intruder alerts. The proper installation and maintenance of these systems are imperative to the safety of facilities and personnel.

Required Knowledge

K 1	types of security systems such as video and card readers
K 2	security system operation
K 3	installation and maintenance requirements such as ambient temperature, location and environmental conditions
K 4	communication networks
K 5	repair/replacement methods
K 6	root cause diagnostics
K 7	safety system operation

Sub-task

C-10.01 Installs facility security systems. (NOT COMMON CORE)

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	yes	no	ND	no	yes	no	no	yes	NV	NV	NV

Key Competencies

C-10.01.01	select type of security system such as closed-circuit TV (CCTV) and intrusion alarm
C-10.01.02	determine location for security system according to environmental conditions, ambient temperature, engineered designs and regulations
C-10.01.03	select and use tools and equipment
C-10.01.04	select mounting hardware for system and devices
C-10.01.05	mount and connect system components according to manufacturers' specifications and engineered designs
C-10.01.06	configure system according to manufacturers' specifications and engineered designs

C-10.01.07	verify operation of security system within specified parameters by using test equipment and procedures
C-10.01.08	back up and document system configuration for future data recovery

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Sub-task

C-10.02 Maintains facility security systems. (NOT COMMON CORE)

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	yes	no	ND	no	yes	no	no	yes	NV	NV	NV

Key Competencies

C-10.02.01	select and use tools and equipment
C-10.02.02	conduct inspection of system components
C-10.02.03	verify system operation according to jurisdictional regulations and manufacturers' specifications for proper operation
C-10.02.04	clean security system components such as camera lenses and covers

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Sub-task

C-10.03 Diagnoses facility security systems. (NOT COMMON CORE)

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	yes	no	ND	no	yes	no	no	yes	NV	NV	NV

Key Competencies

C-10.03.01	select and use tools and equipment such as multimeters and hand-held monitors
C-10.03.02	select and use diagnostic software to determine system faults
C-10.03.03	identify probable root cause and location of faults
C-10.03.04	determine steps required to address deficiencies based on results of root cause analysis such as replacement of power supply and camera lens

Sub-task

C-10.04 Repairs facility security systems. (NOT COMMON CORE)

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	yes	no	ND	no	yes	no	no	yes	NV	NV	NV

Key Competencies

C-10.04.01	select and use tools and equipment such as multimeters and hand-held monitors
C-10.04.02	select replacement components according to manufacturers' specifications
C-10.04.03	replace faulty components and devices according to manufacturers' specifications and procedures
C-10.04.04	verify operation of facility security systems and devices are within specified parameters by using test equipment and procedures

Task 11 Installs and services safety instrumented systems (SISs).

Context

SISs are used to reduce the risk and eliminate the likelihood of a previously identified safety, health and environmental event ranging from minor equipment damage to the uncontrollable release of energy or material. The ultimate goal is to bring the process to a safe state in a timely manner.

The proper installation and maintenance of these systems are imperative to the safety of facilities, personnel and environment.

Required Knowledge

K 1	layers of protection analysis (LOPA) and risk reduction
K 2	safety integrity level (SIL)/reliability of the SIS to get the process to a safe state
K 3	safety instrumented functions (SIFs) such as pressure relief and redundant control valves
K 4	independence of process control systems
K 5	importance of documentation when making changes and performing routine maintenance and testing
K 6	maintenance requirements such as partial close times and valve close times
K 7	SIS dedicated components such as cables, controllers, transmitters and valves

K 8	component specifications for SISs
K 9	difference in commissioning and testing SISs versus other basic process control systems

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Sub-task

C-11.01 Installs SISs

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-11.01.01	identify hazardous condition of the process
C-11.01.02	label SIS components clearly due to importance of dedicated purpose
C-11.01.03	verify accuracy and operation of SIS components according to specifications
C-11.01.04	select mounting hardware for the system and components according to manufacturers' specifications and engineered designs
C-11.01.05	verify and determine location of SIS components to ensure process can be brought to a safe state
C-11.01.06	position and mount SIS components independently from process control components
C-11.01.07	select and use tools and equipment such as stop watches and high accuracy pressure calibrators
C-11.01.08	verify operation of SISs and components within specified parameters by using test equipment, documentation and established procedures
C-11.01.09	back up and document configuration settings for future data recovery, and notify appropriate personnel

Sub-task

C-11.02 Configures SISs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-11.02.01	select and use tools, equipment and software according to manufacturers' recommendations
C-11.02.02	update firmware
C-11.02.03	upload and download SIS controller programs
C-11.02.04	program and verify SIS controllers and input/output (I/O) devices to achieve safe state according to pre-determined hazardous conditions, codes, manufacturers' specifications, and company and industry standards
C-11.02.05	configure external communication with other systems and devices
C-11.02.06	back up and document programming, configuration and parameters for future data recovery, and notify appropriate personnel

Sub-task

C-11.03 Maintains SISs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-11.03.01	select and use tools and equipment
C-11.03.02	visually inspect system components for faults
C-11.03.03	perform self-diagnostics and observe alarm indicators, and interpret results
C-11.03.04	perform function checks of components for factors such as response times and operation of power supplies
C-11.03.05	perform routine function testing of SIS
C-11.03.06	back up and document programming, configuration and parameters for future data recovery, and notify appropriate personnel

Sub-task

C-11.04 Diagnoses SISs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-11.04.01	verify operation and configuration of SISs are within specified parameters by using test equipment and procedures
C-11.04.02	select and use diagnostic tools and equipment, documentation and procedures
C-11.04.03	check SIS operations to identify network and communication problems
C-11.04.04	perform function checks of components for factors such as response times and power supplies
C-11.04.05	perform self-diagnostics and observe alarm indicators, and interpret results
C-11.04.06	analyze process information such as trends and operator logs
C-11.04.07	identify probable root cause and location of faults
C-11.04.08	determine steps required to address deficiencies based on results of root cause analysis such as replacement of components

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Sub-task

C-11.05 Repairs SISs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-11.05.01	select and use repair tools, equipment and software
C-11.05.02	replace defective SIS components such as valves, transmitters and power supplies according to job procedures, documentation and manufacturers' recommendations
C-11.05.03	restore program and configuration from back-up
C-11.05.04	select SIS replacement parts according to existing component specifications and SIF documentation
C-11.05.05	perform function checks of repaired/replaced components for factors such as response times and operation of power supplies

C-11.05.06	back up and document programming, configuration and parameters for future data recovery, and notify appropriate personnel
C-11.05.07	identify impact to processes for component to be repaired when working on SIS

BLOCK D HYDRAULIC, PNEUMATIC AND ELECTRICAL SYSTEMS

Trends	Environmental concerns are still driving the trends in how industry is designing devices and systems. Equipment efficiencies and reduced emissions are some of the main goals as there are stricter government regulations and company standards for reducing the carbon footprint. For example, pneumatically-driven equipment is being replaced by electrically-driven equipment powered by alternate sources such as solar and wind. The efficiency and durability of hydraulically-driven equipment are increasing. Automation and control of these systems is also increasing.
Related Components (including, but not limited to)	**Hydraulic equipment**: hydraulic fluids and filters, pumps, control valves, regulators, safety valves, solenoids. **Pneumatic equipment**: air dryers, conditioning components (filter assemblies, volume boosters), compressors, regulators, safety valves, solenoids. **Electrical equipment**: alternating current/direct current (AC/DC) power supplies, uninterruptible power supplies (UPS), circuit boards, transformers, relays.
Tools and Equipment	See Appendix A.

Task 12 Installs and services control devices for hydraulic systems.

Context Hydraulic equipment is used to supply energy and to control equipment and processes through the use of liquids. Hydraulic equipment is used for higher pressure applications. Instrumentation and control technicians install, maintain, diagnose and repair control devices for hydraulic systems.

Required Knowledge

K 1	hydraulic theories and equipment operation
K 2	types of hydraulic equipment, components and devices such as hoses, piping, fittings, pumps, filters and regulators
K 3	types of hydraulic oils such as synthetic and conventional, and their characteristics and specifications
K 4	cleanliness and filtering standards required for hydraulic systems
K 5	hydraulic system specifications
K 6	hazards related to hydraulic systems such as high pressures, high temperatures, leaks and release of stored energy
K 7	control device specifications such as pressure, volume, level and capacity to meet operational demands
K 8	pressure, level and flow calibration instruments such as pressure calibrators and multimeters
K 9	temperature calibration instruments such as temperature baths, dry block calibrators and infrared thermometers
K 10	accuracy and limitations of calibration instruments
K 11	required calibrating parameters of measuring devices such as zero, span, range, repeatability, specific gravity and accuracy
K 12	maintenance procedures, documentation and schedules
K 13	repair/replacement methods
K 14	root cause diagnostics

Sub-task

D-12.01 Installs control devices for hydraulic systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	no	no	yes	yes	yes	NV	NV	NV

Key Competencies

D-12.01.01	select tools and components according to system specifications to complete installation
D-12.01.02	determine location of control devices according to standard codes and practices, and manufacturers' recommendations
D-12.01.03	connect control devices such as solenoids, switches, gauges and actuators using materials such as tubing and fittings
D-12.01.04	verify operation of hydraulic equipment and control devices to ensure they are within specified parameters by using test equipment and procedures

Sub-task

D-12.02 Maintains control devices for hydraulic systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-12.02.01	select and use tools and test equipment such as infrared thermometers, gauges and multimeters
D-12.02.02	test and verify control devices according to operational parameters such as pressure, temperature, flow and level
D-12.02.03	replace components such as filters and fluids
D-12.02.04	calibrate and adjust control devices according to operational parameters and maintenance schedules

Sub-task

D-12.03 Diagnoses control devices for hydraulic systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-12.03.01	select and use diagnostic tools and equipment such as temperature sensors, gauges and multimeters
D-12.03.02	identify probable root cause and location of faults using diagnostic tools such as infrared thermometers, gauges and multimeters
D-12.03.03	refer to maintenance documentation and historical data to assist in root cause analysis
D-12.03.04	determine steps required to address deficiencies based on results of root cause analysis

Sub-task

D-12.04 Repairs control devices for hydraulic systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-12.04.01	select tools and replacement components to repair according to system specifications and applications
D-12.04.02	repair faulty control devices by using methods such as replacing parts, cleaning and calibrating
D-12.04.03	replace faulty control devices with suitable replacement according to system specifications
D-12.04.04	verify operation before returning to service

Task 13 Installs and services pneumatic equipment.

Context Pneumatic equipment is used to supply energy and to control equipment and processes through the use of compressed air, nitrogen and process gases. Instrumentation and control technicians install maintain, diagnose and repair pneumatic equipment.

Required Knowledge

K 1	pneumatic theories and specifications
K 2	types of pneumatic equipment, components and devices such as compressors, air dryers, safety valves, switches, solenoids and regulators
K 3	compressed gas qualities such as dew point, presence of particulates and oil contamination
K 4	pneumatic equipment operation
K 5	combustible gases and venting practices
K 6	hazards of pneumatic systems such as high pressures, high temperatures and hazardous gases
K 7	pressure, level and flow calibration instruments such as pressure calibrators and multimeters
K 8	temperature calibration instruments such as temperature baths, dry block calibrators and infrared thermometers
K 9	accuracy and limitations of calibration instruments
K 10	required calibrating parameters of measuring devices such as zero, span, range, repeatability and accuracy
K 11	maintenance procedures, documentation and schedules
K 12	repair/replacement methods
K 13	root cause diagnostics

Sub-task

D-13.01 Installs pneumatic equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-13.01.01	determine system requirements such as pressure, volume and capacity
D-13.01.02	select components and tools according to system requirements
D-13.01.03	determine location of pneumatic equipment according to standard codes and practices, and manufacturers' recommendations
D-13.01.04	connect system components such as regulators, separators and tubing
D-13.01.05	calibrate pneumatic control devices such as pressure switches, regulators and gauges
D-13.01.06	verify operation of pneumatic equipment is within specified parameters by using test equipment and procedures

Sub-task

D-13.02 Maintains pneumatic equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-13.02.01	select and use tools and equipment such as infrared thermometers, gauges, dew point testers and ultrasonic leak detectors
D-13.02.02	test and verify control devices according to system specifications such as pressure, temperature, flow and dew point
D-13.02.03	calibrate and adjust control devices according to system specifications and maintenance schedules
D-13.02.04	change system components and materials such as filters and desiccant

Sub-task

D-13.03 Diagnoses pneumatic equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-13.03.01	select and use tools and equipment such as temperature sensors, pressure gauges and multimeters
D-13.03.02	identify probable root cause and location of faults using diagnostic tools and testing procedures
D-13.03.03	refer to maintenance documentation and historical data to assist in root cause analysis
D-13.03.04	determine steps required to repair faults and address deficiencies based on results of root cause analysis

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Sub-task

D-13.04 Repairs pneumatic equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-13.04.01	select tools and replacement components to repair according to system specifications and applications
D-13.04.02	repair faulty components by using methods such as replacing parts, cleaning, and calibrating
D-13.04.03	remove faulty system components according to job procedures and manufacturers' recommendations
D-13.04.04	replace faulty control devices with suitable replacements according to system specifications
D-13.04.05	verify operation before returning to service

Task 14 Installs and services electrical and electronic equipment.

Context

Electrical and electronic equipment is used to supply energy and to control equipment and processes through the use of electricity. Instrumentation and control technicians install, maintain, diagnose and repair electrical and electronic equipment. They work on electrical and electronic equipment directly related to process control and often in conjunction with electricians on electrical power sources.

Required Knowledge

K 1	electrical theories and formulas such as Ohm's Law, Kirchoff's Laws and Faraday's Law
K 2	power quality, specifications and hazards
K 3	types of electrical equipment such as AC/DC power supplies and UPS
K 4	electrical and electronic equipment operation
K 6	hazardous locations
K 7	CEC and jurisdictional regulations
K 8	types of batteries and associated hazards
K 9	accuracy and limitations of calibration instruments
K 10	required tolerances of electrical and electronic equipment such as voltage, voltage ripple, current, repeatability and accuracy
K 11	maintenance procedures, documentation and schedules
K 12	repair/replacement methods
K 13	root cause diagnostics

Sub-task

D-14.01 Installs electrical and electronic equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-14.01.01	determine system requirements such as voltage, current and power
D-14.01.02	select components according to jurisdictional regulations, system requirements, hazards and engineered designs
D-14.01.03	determine location of system equipment according to jurisdictional regulations, system requirements, hazards and engineered designs
D-14.01.04	connect system components such as power supplies, batteries and fuses
D-14.01.05	verify operation of electrical and electronic equipment is within specified parameters by using test equipment and calibration procedures

Sub-task

D-14.02 Maintains electrical and electronic equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-14.02.01	select and use tools and equipment such as multimeters, oscilloscopes and clamp-on ammeters
D-14.02.02	inspect system and components according to specifications and maintenance schedules for conditions such as under voltage and over current
D-14.02.03	verify system operating parameters and specifications such as voltage and current using electrical formulas and theories
D-14.02.04	perform routine battery maintenance activities such as checking voltage and fluid level, and cleaning terminal corrosion

Sub-task

D-14.03 Diagnoses electrical and electronic equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-14.03.01	select and use tools and equipment such as multimeters, hydrometers, oscilloscopes, diagnostic software and clamp-on ammeters
D-14.03.02	perform sensory inspection to detect abnormal noises, heat and odours
D-14.03.03	perform battery load test to indicate conditions of the battery performance
D-14.03.04	identify probable root cause and location of faults using diagnostic tools, testing procedures and electrical formulas and theories
D-14.03.05	refer to maintenance documentation and historical data to assist in root cause analysis
D-14.03.06	determine steps required to repair faults

Sub-task

D-14.04 Repairs electrical and electronic equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-14.04.01	select and use tools and equipment such as hand tools, multimeters and clamp-on ammeters
D-14.04.02	select replacement components such as fuses, batteries, relays, control boards and cables, according to system specifications, manufacturers' specifications and applications
D-14.04.03	remove/replace faulty system components according to job procedures and manufacturers' recommendations
D-14.04.04	verify operation and calibration if applicable before returning to service

BLOCK E — FINAL CONTROL DEVICES

Trends

There is an increase in the use of variable speed drives (VSDs) for motor control and to replace process control valves in control applications to reduce energy use. Smart electronic positioners are replacing pneumatic positioners. There is an increased use of self-diagnostic software to determine, enunciate and facilitate maintenance.

Related Components (including, but not limited to)

Valves: pinch, globe, plug, gate, ball, butterfly, v-ball.

Actuators (pneumatic, hydraulic, electric): cylinders, diaphragms, springs, motors.

Positioners (pneumatic, electric/electronic): levers, nozzles, flappers, diaphragms, feedback linkages, current to pneumatic (I/P) transducers, bellows.

VSDs

Other components: tubing, fittings, wiring.

Tools and Equipment

See Appendix A.

Task 15 — Installs and services valves.

Context

Valves, in conjunction with actuators and positioners, manipulate the process medium. Valves must be correctly installed and maintained to ensure system efficiency, optimum production and safety of operations and equipment. Maintenance of valves includes routine and preventative maintenance. Diagnosis includes troubleshooting and locating faults such as leaks and wear.

Required Knowledge

K 1	types of valves such as globe, pinch, plug, gate, ball, butterfly and v-ball
K 2	process equipment operation and performance expectations
K 3	characteristics and applications of valves
K 4	types and applications of packing such as teflon, graphite and rope
K 5	possible faults of valves such as leaks, valve passing and damaged parts
K 6	repair procedures such as disassembly, assembly and replacement of parts

K 7	hazardous process applications
K 8	process requirements
K 9	hazards of stored mechanical energy such as spring compression and compressed air
K 10	maintenance procedures, documentation and schedules
K 11	root cause diagnostics

Sub-task

E-15.01 Installs valves.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-15.01.01	select type of valve to be installed according to application, engineered designs and manufacturers' specifications
E-15.01.02	select and use installation tools and equipment according to application requirements, torque specifications and size of valves
E-15.01.03	select and install gasket material and mounting hardware according to application
E-15.01.04	mount valve using methods such as bolting, welding, flanging and threading
E-15.01.05	orientate valve according to manufacturers' specifications in order to prevent premature valve failure and ensure proper function
E-15.01.06	verify operation is within specified parameters by using test equipment and calibration procedures

Sub-task

E-15.02 Maintains valves.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-15.02.01	inspect valves according to specifications and maintenance schedule for conditions such as packing leaks, worn parts and stem wear
E-15.02.02	lubricate valve stems, bushings and bearings according to manufacturers' specifications
E-15.02.03	verify valve assembly strokes smoothly throughout travel
E-15.02.04	adjust open and close positions of valves
E-15.02.05	document information such as valve stroke, wear and overall condition

Sub-task

E-15.03 Diagnoses valves.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-15.03.01	select and use diagnostic tools and equipment such as valve diagnostic software, dial gauges and pressure gauges
E-15.03.02	interpret valve signature from diagnostic software to assess conditions such as seat load and sticking valves
E-15.03.03	determine probable root cause and location of faults and identify required repairs

Sub-task

E-15.04 Repairs valves.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-15.04.01	select and use tools and equipment such as packing pullers and seat pullers
E-15.04.02	disassemble valve according to job procedures and manufacturers' recommendations
E-15.04.03	select replacement parts such as cage, plug and seat according to valve specifications and process applications
E-15.04.04	re-assemble the valve according to job procedures and manufacturers' recommendations

Task 16 Installs and services actuators.

Context Actuators adjust the position of valves. Instrumentation and control technicians install, maintain, diagnose and repair actuators to ensure proper operation of valves and other control devices.

Required Knowledge

K 1	types of actuators such as pneumatic, hydraulic and electric
K 2	applications of actuators such as fail-open and fail-close
K 3	actuator actions such as spring return, double-acting and rotary
K 4	manufacturers' installation specifications
K 5	actuator components such as diaphragms, plates, couplings, springs, bushings and o-rings
K 6	possible faults of actuators such as leaking diaphragms, broken springs and damaged or worn o-rings
K 7	operating environment
K 8	process requirements
K 9	hazardous process applications
K 10	hazards of stored mechanical energy such as spring compression and compressed air

K 11	maintenance procedures, documentation and schedules
K 12	repair/replacement methods
K 13	root cause diagnostics

Sub-task

E-16.01 Installs actuators.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-16.01.01	select actuator to be installed according to valve type, application and manufacturers' specifications
E-16.01.02	select and use installation tools and equipment according to application requirements and size of actuator
E-16.01.03	select, orientate and mount actuator according to manufacturers' specifications and engineered designs
E-16.01.04	connect and terminate actuator using methods such as wiring, tubing and bolting according to application requirements
E-16.01.05	benchset actuator to overcome static process pressure and ensure seat load
E-16.01.06	check actuator to verify operation is within specified parameters by using test equipment and calibration procedures

Sub-task

E-16.02 Maintains actuators.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-16.02.01	inspect actuator according to specifications and maintenance schedule for conditions such as damaged diaphragms and o-ring seals
E-16.02.02	lubricate actuator stems, bushings and bearings according to manufacturers' specifications
E-16.02.03	verify that the assembly strokes smoothly throughout travel
E-16.02.04	document information such as valve stroke, wear and overall condition

Sub-task

E-16.03 Diagnoses actuators.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-16.03.01	select and use diagnostic tools and equipment such as diagnostic software, dial gauges and pressure gauges
E-16.03.02	interpret actuator travel to assess faults such as faulty springs and limits
E-16.03.03	determine probable root cause and location of faults and identify required repairs

Sub-task

E-16.04 Repairs actuators.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-16.04.01	select and use tools and equipment such as spring compressors and seal pullers
E-16.04.02	disassemble actuator according to job procedures and manufacturers' specifications
E-16.04.03	select replacement parts required according to actuator specifications and process applications
E-16.04.04	lubricate actuators according to manufacturers' specifications
E-16.04.05	reassemble actuator with replacement components such as o-rings, diaphragms and pistons according to job procedures and manufacturers' specifications
E-16.04.06	verify operation and calibration if applicable before returning to service

Task 17 Installs and services positioners.

Context Positioners are used for the precise positioning of valves, actuators and equipment. They must be properly installed, calibrated and maintained to ensure system efficiency and reliability.

Required Knowledge

K 1	types of positioners such as rotary, pneumatic and electronic
K 2	positioner components such as levers, nozzles, flappers, diaphragms, feedback devices, I/P transducers and bellows
K 3	auxiliaries such as position switches and boosters
K 4	positioner actions, characterizations and parameters
K 5	calibration and diagnostic software
K 6	repair/replacement methods

K 7	maintenance procedures, documentation and schedules
K 8	root cause diagnostics

Sub-task

E-17.01 Installs positioners.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-17.01.01	select positioner to be installed according to application and manufacturers' specifications
E-17.01.02	select positioner action such as fail-close or fail-open according to process and engineered designs
E-17.01.03	select and use installation tools and equipment such as hand-held configurators and loop calibrators according to application requirements
E-17.01.04	select mounting hardware according to application
E-17.01.05	orientate and mount positioner to actuator according to manufacturers' specifications and engineered designs
E-17.01.06	connect and terminate positioner using methods such as wiring, tubing and bolting according to application requirements
E-17.01.07	configure and calibrate positioner according to specifications
E-17.01.08	check positioner to verify operation is within specified parameters by using test equipment and procedures
E-17.01.09	back up and document configuration and calibration settings for future data recovery

Sub-task

E-17.02 Maintains positioners.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-17.02.01	inspect positioner according to specifications and maintenance schedule for conditions such as air leaks and feedback faults
E-17.02.02	lubricate and clean positioner components according to manufacturers' specifications
E-17.02.03	verify that the assembly strokes smoothly and does not oscillate throughout travel
E-17.02.04	adjust, calibrate and tune positioner according to valve specifications and process application
E-17.02.05	document information such as valve stroke, wear and overall condition

Sub-task

E-17.03 Diagnoses positioners.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-17.03.01	select and use diagnostic tools and equipment such as diagnostic software, dial gauges and pressure gauges
E-17.03.02	verify positioner operation and configuration to assess faults such as plugged nozzles and defective I/P transducer
E-17.03.03	determine probable root cause and location of faults and identify required repairs

Sub-task

E-17.04 **Repairs positioners.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-17.04.01	select and use tools and equipment such as configurators and loop calibrators
E-17.04.02	disassemble positioner according to job procedures and manufacturers' specifications
E-17.04.03	select replacement parts required according to positioner specifications and applications
E-17.04.04	reassemble positioner with replacement components such as o-rings, I/P transducers and feedback devices according to job procedures and manufacturers' recommendations

Task 18 Configures and services variable speed drives (VSDs).

Context

VSDs are used for the precise control of electric motors. For the purpose of this analysis, VSDs include variable frequency drives (VFDs). Instrumentation and control technicians configure, maintain, diagnose and repair VSDs to ensure system efficiency and reliability.

Required Knowledge

K 1	types of VSDs such as VFDs and DC drives
K 2	VSD parameters and applications such as power requirements, amperage, limitations, and input and output devices
K 3	VSD configurations and interfaces
K 4	diagnostic features of VSDs such as fault codes and error codes
K 5	repair/replacement methods
K 6	maintenance procedures, documentation and schedules
K 7	root cause diagnostics

Sub-task

E-18.01 Configures VSDs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-18.01.01	select and use tools and equipment such as software and configurators
E-18.01.02	calibrate VSDs according to manufacturers' instructions, application and data sheets
E-18.01.03	set initial parameters and settings of VSDs according to engineered designs, manufacturers' instructions, application and data sheets
E-18.01.04	back up and document configuration and calibration settings for future data recovery
E-18.01.05	test and verify operation of VSD is within specified parameters by using operational and maintenance procedures

Sub-task

E-18.02 Maintains VSDs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	no	yes	yes	yes	NV	NV	NV

Key Competencies

E-18.02.01	select and use tools and equipment such as multimeters, software, configurators and loop calibrators
E-18.02.02	inspect VSDs for abnormal conditions such as contamination, loose connections and excessive heat
E-18.02.03	verify the inputs and outputs
E-18.02.04	upgrade software and firmware to avoid obsolescence and to resolve existing or previous software deficiencies
E-18.02.05	follow recommended maintenance practices and schedules according to manufacturers' specifications
E-18.02.06	back up and document configuration settings for future data recovery

Sub-task

E-18.03 Diagnoses VSDs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-18.03.01	select and use tools and equipment such as tachometers, megohmmeters, computers, multimeters and configurators
E-18.03.02	interpret VSD fault codes and indicator lights to identify conditions such as overcurrent, under-voltage and ground faults
E-18.03.03	determine probable root cause and location of faults and identify required repairs

Sub-task

E-18.04 Repairs VSDs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	no	yes	yes	yes	NV	NV	NV

Key Competencies

E-18.04.01	select and use tools and equipment such as software and configurators
E-18.04.02	select replacement parts according to applications and manufacturers' specifications
E-18.04.03	replace defective components according to job procedures and manufacturers' recommendations
E-18.04.04	test and adjust operating parameters according to application requirements
E-18.04.05	verify operation before returning to service

Trends	Communication networks such as Ethernet and Foundation Fieldbus are becoming more prominent. Wireless communication between devices is an emerging technology for industrial applications. There is a trend to having greater functionality built into end devices and the control systems, resulting in fewer stand-alone signal converters. The use of the open protocols such as Open Platform Communications (OPC) is increasing and eliminating the need for protocol converters in control networks.
Related Components (including, but not limited to)	**Control network systems**: modems, cables (fibre optics, coaxial, twisted pair), antennas, filters, cards, software, firmware, links (radio, cellular, satellite). **Signal converters (digital to analog [D/A], analog to digital [A/D], current to pneumatic, pneumatic to electrical, current transformers, potential transformers, voltage to pneumatic)**: wiring, tubing, connections, cards, software, firmware. **Gateways, bridges, switches and media converters**: microprocessor-based devices.
Tools and Equipment	See Appendix A.

Task 19 Installs and services control network systems.

Context

Control network systems transfer process information and data between components and equipment. These systems are also used for configuration and diagnostics of network and control devices. Instrumentation and control technicians install, configure, diagnose, maintain and repair these systems.

Required Knowledge

K 1	types of communication media and connection methods such as fibre optics, wiring and wireless
K 2	communication protocols such as Foundation Fieldbus, Profibus, MODBUS, Transport Control Protocol/Internet Protocol (TCP/IP) and HART
K 3	communication standards such as RS232, RS422, RS/TIA/EIA485 and Ethernet
K 4	potential causes of interference such as overlapping channels and Wi-Fi
K 5	standards, codes and licences
K 6	network topologies
K 7	features and limitations of protocols, topologies and programming languages
K 8	grounding methods and ground loops
K 9	addressing structures
K 10	security of communication systems and devices
K 11	root cause diagnostics
K 12	repair/replacement methods
K 13	maintenance procedures, documentation and schedules

Sub-task

F-19.01 **Performs installation and configuration on control network systems.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-19.01.01	select system components such as switches, repeaters and wiring according to application and environment
F-19.01.02	mount components such as switches/hubs/routers, repeaters and antennas in locations according to manufacturers' specifications and engineered designs
F-19.01.03	terminate and label connections using connectors, tools and supplies according to communications media and network equipment being used
F-19.01.04	connect network equipment using communications media such as fibre optics, wireless and wiring
F-19.01.05	verify operation of system is within specified parameters by testing signal strength and throughput, and checking error counters
F-19.01.06	configure network equipment using software and hardware to meet system design criteria such as setting addressing and port parameters
F-19.01.07	back up and document configuration settings for future data recovery

Sub-task

F-19.02 **Diagnoses control network systems.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-19.02.01	perform visual inspection of network equipment to detect signs of fault such as physical damage and faulty connections
F-19.02.02	perform physical inspection of cabling and connections using methods such as cleaning and reseating connections
F-19.02.03	observe indicator and status lights to identify abnormal operation
F-19.02.04	test system components for faults using diagnostic tools and equipment such as analyzers and multimeters

F-19.02.05	verify configuration to ensure no corruption exists using software and documentation
F-19.02.06	refer to maintenance documentation and historical data to assist in root cause analysis
F-19.02.07	determine steps required to address deficiencies based on results of root cause analysis

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Sub-task

F-19.03 **Performs maintenance and repairs on control network systems.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-19.03.01	use software to check error logs, signal strength and counter readings to identify eventual issues through data analysis of patterns
F-19.03.02	clean network equipment and connectors (fibre optics) according to manufacturers' recommendations
F-19.03.03	repair/replace components such as repeaters and power supplies based on results of root cause diagnostic
F-19.03.04	verify operation before returning to service
F-19.03.05	back up and document configuration settings for future data recovery

Task 20 Installs and services signal converters.

Context

Signal converters convert one form of process signal to another that will be understood by the process control system. For example, they may convert analog to digital signals. They also may convert one type of energy to another such as electric to pneumatic. Instrumentation and control technicians install, configure, calibrate, diagnose, maintain and replace these devices.

Required Knowledge

K 1	types of signal converters such as D/A, A/D and I/P
K 2	types of signal transmission systems such as tubing and wiring
K 3	wiring and tubing connection methods
K 4	potential causes of interference
K 5	standards and codes
K 6	features and limitations of signal converters such as accuracy and repeatability
K 7	grounding methods
K 8	configuration methods
K 9	signal converters that require calibration
K 10	calibration instruments and testing tools such as multimeters, hand-held configurators and current generators
K 11	required calibrating methods and parameters of measuring devices such as zero, span, range, repeatability and accuracy
K 12	impact of calibration on process
K 13	maintenance procedures, documentation and schedules
K 14	repair/replacement methods
K 15	root cause diagnostics

Sub-task

F-20.01 Performs installation and configuration of signal converters.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-20.01.01	select signal converter according to required fu .tionality and environment
F-20.01.02	select wiring and/or tubing according to application requirements
F-20.01.03	mount signal converters according to engineered designs and manufacturers' specifications
F-20.01.04	terminate wiring and/or tubing according to engineered designs and manufacturers' specifications
F-20.01.05	configure signal converter according to process requirements and specifications
F-20.01.06	calibrate signal converter to required specifications using calibration instruments according to standard codes and practices
F-20.01.07	back up and document settings for future data recovery

Sub-task

F-20.02 Diagnoses signal converters.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-20.02.01	perform inspection to detect faults such as leaks, physical damage and faulty connections
F-20.02.02	check function of converters to isolate problems such as plugged relay and inadequate power
F-20.02.03	check calibration and configuration of signal converter using diagnostic tools and equipment such as multimeters and hand-held configurators

F-20.02.04	refer to maintenance documentation and historical data to assist in root cause analysis
F-20.02.05	determine steps required to address deficiencies based on results of root cause analysis

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Sub-task

F-20.03 Performs maintenance and repairs on signal converters.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	no	yes	yes	yes	NV	NV	NV

Key Competencies

F-20.03.01	perform inspection to detect faults such as leaks, loose connections and corrosion
F-20.03.02	perform function check of signal converters to confirm proper operation
F-20.03.03	perform scheduled maintenance activities such as replacing filters, cleaning nozzles and calibrating according to manufacturers' recommendations and job procedures
F-20.03.04	clean devices to address conditions such as contamination, corrosion and blockages
F-20.03.05	repair/replace signal converters and components such as diaphragms, pneumatic relays and modules based on results of root cause analysis
F-20.03.06	repair leaks using methods such as tightening fittings and replacing gaskets and seals
F-20.03.07	verify operation and calibration if applicable before returning to service
F-20.03.08	back up and document settings for future data recovery

Task 21 Installs and services gateways, bridges and media converters.

Context Gateways, bridges and media converters convert process information between media types, devices and systems. Instrumentation and control technicians install, configure, maintain, diagnose and repair these systems.

Required Knowledge

K 1	types of communication media such as fibre optics and cabling
K 2	types of network, protocol and addressing structures
K 3	types of gateways, bridges and media converters
K 4	data structures and system formats
K 5	limitations of gateways, bridges, media converters and connected systems such as memory size, transmission speed and distance
K 6	maintenance procedures, documentation and schedules
K 7	repair/replacement methods
K 8	root cause diagnostics

Sub-task

F-21.01 Performs installation and configuration of gateways, bridges and media converters.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-21.01.01	select gateways, bridges and media converters according to application requirements
F-21.01.02	mount gateways, bridges and media converters according to engineered designs and device limitations
F-21.01.03	select cabling according to application requirements
F-21.01.04	connect gateways, bridges and media converters according to engineered designs and device limitations
F-21.01.05	select and use tools and equipment such as software and hardware

F-21.01.06	set protocols, addressing and port parameters according to engineered designs, documentation and manufacturers' specifications
F-21.01.07	back up and document configuration settings for future data recovery

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Sub-task

F-21.02 Diagnoses gateways, bridges and media converters.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-21.02.01	perform sensory inspection of network equipment to detect signs of faults such as physical damage and faulty connections
F-21.02.02	perform physical inspection of cabling and connections using methods such as cleaning and reseating connections
F-21.02.03	observe indicator and status lights to identify faulty operation
F-21.02.04	test system components for faults using diagnostic tools and equipment such as protocol analyzers, software and multimeters
F-21.02.05	verify configuration to ensure no corruption exists using software and documentation
F-21.02.06	determine response time of data transfer to identify faults
F-21.02.07	refer to maintenance documentation and historical data to assist in root cause analysis
F-21.02.08	determine steps required to address faults based on results of root cause analysis

Sub-task

F-21.03 **Performs maintenance and repairs on gateways, bridges and media converters.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	no	yes	yes	yes	NV	NV	NV

Key Competencies

F-21.03.01	use software to check error logs, tables and registers to identify eventual issues through data analysis of patterns
F-21.03.02	perform inspection to detect faults such as heat build-up, humidity and contamination
F-21.03.03	observe indicator lights to ensure proper operation
F-21.03.04	clean gateways, bridges, media converters and connectors (fibre optics) according to manufacturers' recommendations
F-21.03.05	refer to maintenance documentation and historical data to assist in root cause analysis
F-21.03.06	replace components such as modules and circuit boards
F-21.03.07	restore and verify configuration
F-21.03.08	verify operation before returning to service
F-21.03.09	back up and document configuration settings for future data recovery

Trends	As communication methods have evolved, the available data to the control system has increased. Alarm management is becoming more popular. Software modelling of process control strategies is also gaining popularity. Programmable Logic Controllers (PLCs) can include Process Safety Systems (PSS) that provide increased redundancy and diagnostics to cover SIS driven functionalities. PLCs are increasingly capable of DCS functionality and vice versa. PLCs are being utilized for smaller process control applications. Due to the increased diversity of available PLC products, company standardization of hardware and configurations is becoming an increased priority. DCSs are becoming more capable of doing SCADA functions such as increased data acquisition. DCS systems are becoming more powerful and able to do more advanced trending and modeling. SCADA systems are becoming more integrated into control systems. With the improvements in computer technology, HMIs are increasingly capable of advanced programming, monitoring and trending. Process control systems for Building Automation systems (BAS) and Heating, Ventilation and Air Conditioning Systems (HVAC) have become more sophisticated.
Related Components (including, but not limited to)	Software, hardware, graphic interfaces, advanced control components, servers, UPS, communication networks and components, printers, automated messaging systems, emergency alarm panels, hardware controllers, software controllers, measurement devices, final control devices, associated process equipment (such as compressors, boilers, pumps, mills). **SCADA**: modems, wireless components (radios, satellite, microwave), PLC, DCS, Master Terminal Unit (MTU), Remote Terminal Unit (RTU), servers, computer equipment, alarm panels.
Tools and Equipment	See Appendix A.

Task 22 Establishes and optimizes process control strategies.

Context Process control strategies are employed and selected to maintain and control the performance of the process. Instrumentation and control technicians determine and optimize these strategies.

Required Knowledge

K 1	process control strategies such as feed forward, cascade and ratio
K 2	controller functions such as direct/reverse action, auto/manual and split range
K 3	mathematical equations employed by strategies such as proportional-integral-derivative (PID)
K 4	various process parameters to be controlled
K 5	control equipment characteristics and limitations
K 6	process control limitations
K 7	manufacturers' equipment requirements
K 8	process requirements
K 9	configuration software
K 10	manufacturers' recommended configuration routines
K 11	interaction of other processes
K 12	failure modes
K 13	multi-variable control processes
K 14	tag descriptors and addressing
K 15	process and instrumentation diagram (P&ID) and Scientific Apparatus Makers Association (SAMA) drawings

Sub-task

G-22.01 Determines process control strategy.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-22.01.01	determine control, process parameters and manipulated variables according to process requirements
G-22.01.02	determine applicable control strategy such as feed forward, cascade, selective and ratio according to process requirements or by following engineered designs
G-22.01.03	develop loop diagram as basis for implementation
G-22.01.04	determine controller action such as forward and reverse
G-22.01.05	determine controller functions such as proportional-integral (PI) and PID

Sub-task

G-22.02 Optimizes process control.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-22.02.01	identify process loop for optimization
G-22.02.02	evaluate strategy's ability to control the process
G-22.02.03	initiate a change in the process to observe how the process control reacts to the change
G-22.02.04	gather process data to evaluate process stability and reactions
G-22.02.05	analyze data and observations to determine the effectiveness of the strategy
G-22.02.06	recognize control and process limitations
G-22.02.07	tune process according to analysis of the data and observations
G-22.02.08	use software to optimize tuning parameters

Task 23 Installs and services stand-alone controllers (SACs).

Context

SACs such as electronic and pneumatic controllers employ control strategies. They control a specific process variable typically for single loop applications rather than multiple processes or large control schemes. They may be configured to receive remote set points. They are not required to be connected to other plant networks.

Required Knowledge

K 1	types of SACs such as pneumatic and electronic
K 2	controller functions and modes such as direct/reverse action, auto/manual and PID
K 3	types of inputs and outputs such as pneumatic and electronic
K 4	connection methods
K 5	operation theory
K 6	operating parameters
K 7	installation conditions such as extreme ambient temperature, cleanliness and contamination
K 8	configuration techniques
K 9	calibration techniques applied to specific control strategies
K 10	calibration and configuration tools such as pneumatic test equipment, hand-held programmers and software
K 11	desired process control and process control strategy, based on process limitations, requirements and engineered designs
K 12	tag descriptors and addressing
K 13	root cause diagnostics
K 14	repair/replacement methods
K 15	maintenance procedures, documentation and schedules

Sub-task

G-23.01 Installs SACs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-23.01.01	select controller according to application, process requirements, control strategy and signal requirements
G-23.01.02	determine mounting requirements and locations according to environmental conditions and area classifications
G-23.01.03	select and use installation tools and equipment
G-23.01.04	connect wiring or tubing to controller according to manufacturers' recommendations and engineered designs

Sub-task

G-23.02 Configures SACs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-23.02.01	select and use tools, equipment and software for configuration according to manufacturers' recommendations
G-23.02.02	develop controller configuration by interpreting process control strategy
G-23.02.03	implement configuration
G-23.02.04	calibrate inputs/outputs (electronic or pneumatic) according to manufacturers' specifications and process requirements
G-23.02.05	tune and verify controller to determine if controller configuration controls the process according to operational requirements
G-23.02.06	back up and document configurations, settings and tuning parameters for future data recovery

Sub-task

G-23.03 Performs maintenance, diagnostics and repairs on SACs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-23.03.01	select and use tools and equipment such as multimeters and software
G-23.03.02	perform routine scheduled maintenance by replacing filters, restrictors, back-up batteries, checking indicating lights and verifying environmental conditions such as temperature and cleanliness
G-23.03.03	diagnose error codes and status lights to identify problem
G-23.03.04	identify probable root causes by investigating symptoms and conditions to determine location of faults
G-23.03.05	determine steps required to address faults based on results of root cause analysis
G-23.03.06	repair and replace electronic components such as I/O modules and power supplies according to job procedures and manufacturers' recommendations
G-23.03.07	repair and replace pneumatic components such as flappers, nozzles and relays according to job procedures and manufacturers' recommendations
G-23.03.08	perform controller alignment according to manufacturers' recommendations
G-23.03.09	restore program and configuration from back-up and return controller to service
G-23.03.10	verify SAC tuning, programming and configuration
G-23.03.11	back up and document SAC program, settings and configuration for future data recovery

Task 24 Installs and services programmable logic controllers (PLCs).

Context PLCs employ control strategies and user-created programs to control multiple loops and systems. These can be used individually or networked with other control systems to operate equipment and facilities efficiently and safely.

Required Knowledge

K 1	types of PLCs supplied by various manufacturers and the differences in their architecture and capabilities
K 2	programming software and version compatibility
K 3	languages such as ladder, function block, sequential function chart and script
K 4	types of components such as power supply, processor, memory and I/O
K 5	grounding methods
K 6	digital, discrete and analog signals
K 7	compatibility with other process control systems
K 8	communication networks and protocols
K 9	installation conditions such as heat, cleanliness and contamination
K 10	manufacturers' specifications and recommendations
K 11	associated software such as word processors, spreadsheets and databases
K 12	tag descriptors and addressing
K 13	configuration parameters
K 14	programming standards
K 15	alarm priorities
K 16	access and security levels
K 17	licensing and service contract requirements
K 18	controlled process
K 19	interaction with process
K 20	effects of maintenance actions or errors
K 21	communication systems used by PLCs
K 22	software and hardware limitations
K 23	obsolescence issues
K 24	service bulletins and alerts
K 25	cause and effects of forcing and bypassing I/Os
K 26	data types such as binary, integer and floating point
K 27	hot standby and redundancy applications

K 28	working offline and online
K 29	maintenance procedures, documentation and schedules
K 30	repair/replacement methods
K 31	root cause diagnostics

Sub-task

G-24.01 Installs PLCs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-24.01.01	select and use installation tools and equipment
G-24.01.02	determine PLC to be installed according to engineered designs, application, and control strategy
G-24.01.03	confirm installation details of PLC
G-24.01.04	mount racks and additional equipment according to engineered designs and common practices
G-24.01.05	connect wiring and network to PLC according to engineered designs such as schematics and drawings, and manufacturers' specifications
G-24.01.06	address environmental conditions such as temperature and contamination

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Sub-task

G-24.02 Configures PLCs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-24.02.01	select and use tools, equipment and software according to manufacturers' recommendations and engineered designs
G-24.02.02	update firmware
G-24.02.03	upload and download PLC programs
G-24.02.04	validate PLC configuration according to card and rack layout

G-24.02.05	program PLC including comments according to process control strategy
G-24.02.06	configure external communication with other systems and devices
G-24.02.07	verify tuning, configuration and programming to determine if PLC controls the process according to operational requirements
G-24.02.08	back up and document programming, configuration, settings and parameters for future data recovery

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Sub-task

G-24.03 Performs maintenance, diagnosis and repairs on PLCs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-24.03.01	select and use tools and equipment such as software and multimeters
G-24.03.02	perform routine scheduled maintenance by replacing back-up batteries , observing indicator lights and verifying environmental conditions such as temperature and cleanliness
G-24.03.03	diagnose error codes, logs and status lights to identify problem
G-24.03.04	identify probable root cause by investigating symptoms and conditions to determine location of faults
G-24.03.05	perform diagnostic procedures such as forcing I/O, setting traps and counters
G-24.03.06	determine steps required to address faults based on results of root cause analysis
G-24.03.07	replace components such as I/O cards, racks and power supplies according to job procedures and manufacturers' recommendations
G-24.03.08	restore program and configuration from back-up
G-24.03.09	verify PLC programming and configuration
G-24.03.10	back up and document PLC program and configuration for future data recovery

Task 25 Installs and services distributed control systems (DCSs).

Context DCSs employ control strategies and user-created programs to control multiple loops and systems. They usually incorporate their own operator interface functionality or graphical user station. These can be used individually or networked with other control systems to operate equipment and facilities efficiently and safely.

Required Knowledge

K 1	types of DCSs, their architecture and their capabilities
K 2	languages such as function block and script
K 3	types of components such as power supply, server, processor, memory and I/O
K 4	cabling and grounding methods
K 5	digital, discrete and analog signals
K 6	compatibility with other process control systems
K 7	communication networks and protocols
K 8	installation conditions such as temperature and contamination
K 9	manufacturers' specifications and recommendations
K 10	DCS programs and associated software such as word processors, spreadsheets and databases
K 11	tag descriptors and addressing
K 12	configuration parameters
K 13	programming consistency issues
K 14	alarm priorities
K 15	access and security levels
K 16	licensing and service contract requirements
K 17	manufacturers' maintenance recommendations
K 18	controlled process
K 19	interaction with process
K 20	effects of maintenance actions or errors
K 21	software and hardware limitations
K 22	service bulletins and alerts
K 23	cause and effects of forcing, disabling and bypassing I/O
K 24	maintenance procedures, documentation and schedules

K 25	repair/replacement methods
K 26	root cause diagnostics

Sub-task

G-25.01 Installs DCSs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-25.01.01	select and use installation tools and equipment
G-25.01.02	assist in determining DCS to be installed according to engineered designs, application, control strategy and company requirements
G-25.01.03	confirm installation details of DCS components such as cabinets, operator stations and servers according to manufacturers' specifications and engineered designs
G-25.01.04	select and install DCS components such as I/O cards and power supplies
G-25.01.05	connect wiring and network to DCS according to manufacturers' recommendations and engineered designs such as loop drawings
G-25.01.06	address environmental conditions such as temperature and contamination

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Sub-task

G-25.02 Configures DCSs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-25.02.01	select and use tools, equipment and software for configuration according to manufacturers' recommendations and company standards
G-25.02.02	update operating software
G-25.02.03	validate DCS configuration according to rack and cabinet layout
G-25.02.04	program DCS, including comments and displays, according to process control strategy and company standards
G-25.02.05	configure external communication with other systems and devices

G-25.02.06	verify tuning, configuration and programming to verify if DCS controls the process according to operational requirements
G-25.02.07	back up and document configuration, settings and parameters for future data recovery

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Sub-task

G-25.03 Performs maintenance, diagnosis and repairs on DCSs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-25.03.01	select and use tools, equipment and software
G-25.03.02	perform scheduled maintenance by replacing back-up batteries, checking indicator lights and verifying environmental conditions such as temperature and cleanliness
G-25.03.03	check power supply for proper voltage level
G-25.03.04	use diagnostic menu to identify problems such as network and communication faults
G-25.03.05	identify probable root cause by investigating symptoms and conditions to determine location of faults
G-25.03.06	determine steps required to address faults based on results of root cause analysis
G-25.03.07	replace components such as I/O cards, racks and power supplies according to job procedures and manufacturers' recommendations
G-25.03.08	restore DCS program and configuration from back-up
G-25.03.09	verify DCS configuration
G-25.03.10	back up and document DCS program and servers for future data recovery

Task 26 Installs and services human machine interface (HMIs).

Context HMIs interface with the controlling devices such as PLC, DCS and SCADA systems in order to allow monitoring and controlling of the process through graphical displays. HMIs often have the ability to provide trending, alarm summaries and historical data collection.

Required Knowledge

K 1	types of HMI software and hardware, design and capabilities
K 2	digital, discrete and analog signals
K 3	compatibility with other process control systems
K 4	communication networks and protocols
K 5	installation conditions such as heat, cleanliness and contamination
K 6	software/hardware manufacturers' specifications and recommendations
K 7	HMI programs and associated software such as word processors, spreadsheets and databases
K 8	tag descriptors and addressing
K 9	configuration parameters
K 10	programming standards
K 11	alarm priorities
K 12	read/write issues
K 13	access and security levels
K 14	controlled process
K 15	interaction with PLC or DCS systems
K 16	effects of maintenance actions or errors
K 17	software limitations
K 18	licensing and service contract requirements
K 19	maintenance procedures, documentation and schedules
K 20	repair/replacement methods
K 21	root cause diagnostics

Sub-task

G-26.01 Installs HMIs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-26.01.01	select and use installation tools and equipment
G-26.01.02	determine HMI according to engineered designs, application, control strategy and company requirements
G-26.01.03	confirm installation details of HMI
G-26.01.04	address environmental conditions such as temperature and contamination
G-26.01.05	mount HMI components according to drawings and common practices
G-26.01.06	connect cabling and network to HMI according to manufacturers' recommendations, company requirements and engineered designs such as schematics and drawings

Sub-task

G-26.02 Configures HMIs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-26.02.01	select and use tools, equipment and software for configuration according to manufacturers' recommendations and company standards
G-26.02.02	update software and firmware
G-26.02.03	validate HMI configuration, including information such as depiction of process control strategy
G-26.02.04	configure external communication with other systems and devices
G-26.02.05	verify that the HMI configuration and programming interface with and control the process variables according to operational requirements
G-26.02.06	back up and document HMI configuration, settings and parameters for future data recovery

Sub-task

G-26.03 Performs maintenance, diagnosis and repairs on HMIs.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-26.03.01	select and use tools, equipment and software according to manufacturers' recommendations and company standards
G-26.03.02	perform scheduled maintenance by replacing back-up batteries and address environmental conditions such as temperature and cleanliness
G-26.03.03	use diagnostic menu to identify problems such as network and communication faults
G-26.03.04	review error messages and logs to isolate problem
G-26.03.05	perform diagnostic procedures such as manipulating process variables, verifying communication status and verifying graphic updates
G-26.03.06	check power supply for proper voltage
G-26.03.07	identify probable root cause by investigating symptoms and conditions to determine location of faults
G-26.03.08	determine steps required to address faults based on results of root cause analysis
G-26.03.09	replace components such as communication modules and power supplies according to job procedures and manufacturers' recommendations
G-26.03.10	restore HMI program and configuration from back-up
G-26.03.11	verify and test HMI configuration
G-26.03.12	back up and document HMI program and configuration for future data recovery

Task 27 — Installs and services supervisory control and data acquisition (SCADA) systems.

Context

SCADA systems are data transmission and acquisition systems for remote control and monitoring of equipment and facilities. They can be used for control applications such as remote shut-down and start-up of equipment. They may have the added ability to store, measure, trend and manipulate data for reporting purposes.

Required Knowledge

K 1	types of SCADA protocols and configurations
K 2	SCADA theory such as remote processes and system interactions
K 3	SCADA equipment such as MTUs, RTUs, PLCs, HMIs, communication systems and interconnection media
K 4	wireless SCADA system components such as satellite, radio and cellular
K 5	servers for data acquisition and storage
K 6	connection methods such as hardwired and wireless
K 7	potential causes of interference
K 8	standards, codes and licences
K 9	alarm priorities
K 10	features and limitations of protocols and programming languages
K 11	grounding methods
K 12	configuration methods such as addressing and networking
K 13	location selection for wireless transmission towers and antennas
K 14	communication protocols such as MODBUS and TCP/IP
K 15	time synchronization and time stamping
K 16	maintenance procedures, documentation and schedules
K 17	repair/replacement methods
K 18	root cause diagnostics

Sub-task

G-27.01 Installs SCADA systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-27.01.01	select SCADA equipment according to engineered designs, application, control strategy and company standards
G-27.01.02	select and use installation tools and equipment
G-27.01.03	mount SCADA components according to drawings and common practices
G-27.01.04	terminate wiring and network to SCADA equipment according to manufacturers' recommendations and engineered designs such as schematics
G-27.01.05	mount and test wireless transmission
G-27.01.06	avoid interference with other systems and processes by methods such as channel and wavelength selection

Sub-task

G-27.02 Configures SCADA systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-27.02.01	select and use tools, equipment and software to configure SCADA systems
G-27.02.02	configure and validate SCADA, including comments and tagging, according to application and company standards
G-27.02.03	update software and firmware
G-27.02.04	upload and download SCADA configurations/database
G-27.02.05	configure external communication with other systems and devices
G-27.02.06	determine if SCADA configuration and programming monitor and/or control the process according to operational requirements
G-27.02.07	back up and document programming, configuration, settings and parameters for future data recovery

Sub-task

G-27.03 Performs maintenance, diagnosis and repairs on SCADA systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-27.03.01	select and use tools, equipment and software
G-27.03.02	monitor network scan times
G-27.03.03	perform inspection, checking indicator lights and verifying environmental conditions such as ambient temperature and cleanliness
G-27.03.04	follow manufacturers' maintenance schedule such as replacing back-up batteries and cleaning solar panels
G-27.03.05	review error messages, logs and status lights to isolate problem
G-27.03.06	use diagnostic procedures such as forcing I/O and setting traps and counters
G-27.03.07	check power source for proper voltage
G-27.03.08	interpret self-diagnostic and alarm indicators
G-27.03.09	test wireless signal strength
G-27.03.10	refer to maintenance documentation and historical data to assist in root cause analysis
G-27.03.11	determine steps required to address faults based on results of root cause analysis
G-27.03.12	replace components such as I/O modules, servers and power supplies according to job procedures and manufacturers' recommendations
G-27.03.13	restore and verify SCADA configuration from back-up
G-27.03.14	back up and document SCADA configuration for future data recovery

APPENDICES

APPENDIX A TOOLS AND EQUIPMENT

Hand Tools

calipers (assorted)
desoldering tool
diagonal cutters
drill bits
easy-outs (extractors)
feeler gauges
flaring tools
flashlight
fuse puller
gasket cutter
gauge pointer puller
grease gun
hammers (assorted)
hand files (assorted)
hex keys (Imperial/Metric)
hexalobular wrench (Torx)
I/C integrated-circuit extractor
knives
knock-out punches
level
magnet
measuring tape
micrometers (assorted)
mirrors
nut drivers (assorted)
o-ring picks
packing puller
pipe threader
pliers (assorted)
pry bar
punches (assorted)
reamers
rubber mallet
saws (assorted)
screw starters
screwdrivers (assorted)
scribers
sockets (Imperial/Metric)
square
steel rule
strap wrenches
tap and die set
torch
torque wrench
tube benders
tube cutters
tweezers
wire brushes
wire crimpers
wire cutters
wire strippers
wrenches (assorted)

Power Tools

air compressor
band saw
cut-off saw
drill press
grinders
hammer drill
heat gun
high pressure grease gun
hydraulic press
hydraulic knock-out punch
impact wrench
jig saw
pipe threader
pneumatic tools
portable electric drill
portable generator
powder actuated tools
pressure and vacuum pumps
reciprocating saw
sandblaster
soldering iron
wire labeler

Electronic Tools and Test Equipment

amp probe
analog multimeter
analyzers
barometer
breakout box
bridges
calibrated oven
capacitance simulators
computer (laptop, desktop and PDA)
current tracer
deadweight tester
decade resistance box
dew point testers (assorted)
digital logic probe
digital multimeter
dry block calibrator
frequency counter
frequency generator
grounding mats
handheld programmer (configurators)
hydrometer
infrared cameras
infrared thermometers
lab scales
laser strength meter
light microscopes
logic clip
loop calibrator/simulator
manometer and standards
microwave leakage meter
millivoltmeter calibrator
mobile phones/pagers/two-way radio
null balance strain indicator
oscilloscope
pH simulator/buffers
pneumatic test stand
portable sound level meter
pressure pump
power supply
pressure calibrator
protocol analyzers
radiation meters
regulators
RPM tester/tachometer
signal generators
signature analyzer
sling psychrometer
stroboscope
temperature bath
temperature calibrator
test gases
test gauges
thermocouple calibrator
thermometer
transistor checker
voltage tester

Electronic Tools and Test Equipment (Continued)

ultrasonic strap on flowmeter
vacuum pumps
variable transformer
vibration table (wobulator)
wireless signal strength tester
wrist ground strap

Access, Work Holding Equipment and Lifting and Hoisting Equipment

bucket truck
C-clamps
chain fall
come-along
crane (overhead, portable)
forklift
hoist basket
ladders
portable cart
prefabricated scaffold
scissor lift
slings
vises (assorted)

Personal Protective Equipment (PPE) and Safety Equipment

apron
cap lamps
coveralls (regular, disposable and fireproof)
ear protection (muffs and plugs)
eye wash bottle
face shield
fall arrest harness
fire extinguishers
first aid kit
flame retardant clothing
gloves
goggles
hard hat
low-voltage gloves
mask (assorted)
personal dosimeter
personal monitor (gas)
radiation survey meter
radiometer
respirators
rubber boots
rubber suits
safety boots
safety glasses
safety lanyards
safety lines
self-contained breathing apparatus
supplied air hood
winter gear

APPENDIX B GLOSSARY

actuator	a controlled hardware device used to implement change in a process
adapter	a device used to make electrical or mechanical connections between items not originally intended for use together
amplifier	a device that enables an input signal to control power from a source independent of the signal and thus be capable of delivering an output that bears some relationship to, and is generally greater than, the input signal
analog signal	any variable signal continuous in both time and amplitude rather than of a pulsed or discrete nature
bellows	a mechanical element of generally cylindrical shape with cylindrical walls containing deep convolutions
benchset	removing a piece of equipment and testing it at the shop; a static setup as opposed to a dynamic setup; this term typically refers to a preload or the amount of pressure forcing valves closed with no process affecting it.
calibrate	to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device
cascade control	a type of controller set-up in which the output of one controller acts as the set point or controlling signal of another controller
configure	to set up a program or computer system for a particular application
control mode	a specific type of control action such as proportional, integral or derivative
control variable	measured variables that can be manipulated by the control system, such as flow, level, pressure and temperature
commission	process of testing and ensuring that installed equipment is operating as per engineered design
diagnose	activities to determine the cause and source of faults and defects

digital bus transmission	exchanging signals and information between system components by means of voltage or current that fluctuate between two levels; these signals represent binary numbers that are interpreted as values
distributed control system (DCS)	a system of dividing plant or process control into several areas of responsibility, each managed by its own controller (processor), with the whole interconnected to form a single entity usually by communication buses of various kinds
feed forward	an industry standard multiple-element process control strategy, in which mathematically predicted errors are corrected before they occur
fibre optic	a transmission system utilizing hair-thin glass fibres through which light is transmitted. Information is transferred by modulating the transmitted light.
Fieldbus	a digital, two-way, multi-drop communication link among intelligent measurement and control devices. It serves as a Local Area Network (LAN) for advanced process control, remote input/output and high speed factory automation applications.
firmware	a communication protocol software (programs or data) that has been written onto read-only memory chips. Firmware is a combination of software and hardware
flume	an open channel device used to measure larger flow rates.
frequency	the number of cycles completed by a periodic quantity on a unit time
Highway Addressable Remote Transducer (HART)	provides digital communication to microprocessor-based (smart) analog process control instruments.
Human Machine Interface (HMI)	a communication protocol the graphical display and control interface between a process and a human operator
input/output (I/O)	all equipment and activity that transfers information into or out of a computer; the transfer of data between the main storage and other devices, from a DCS or PLC to a transmitter

install	activities performed which include mounting, and process connections (to process and control systems)
instrumentation	a collection of instruments or their application for the purpose of observation, measurement or control.
Instrumentation, Systems and Automation Society (ISA) / International Society of Automation (ISA)	an engineering society that develops and maintains defined standards for both scientific and technical areas of process control and automation
interface	the place at which systems, such as a computer and a peripheral, meet and interact with each other
kinetic	the energy that a body possesses as a result of its motion
maintain	routine preventative activities performed to ensure reliability and to detect potential faults
Modbus	a serial communications protocol originally published by Modicon; allows for communication between many devices connected to the same network, for example a system that measures temperature and humidity and communicates the results to a computer
module	an assembly of interconnected components which constitutes an identifiable device, instrument or piece of equipment; can be removed, tested as a unit and replaced with a spare
network	the interconnection of devices sharing a communications protocol
optimize	a series of activities performed to make the process and its control function close to or better than specification
port	a signal input (access) or output (egress) point
power supply	a device that produces one or more voltages for the operation of electronic and logic devices
process	physical or chemical change of matter or conversion of energy such as change in pressure, temperature, speed, electrical potential

Profibus	a communication protocol
program	a list of instructions that a computer will execute to perform a certain task
Programmable Logic Controller (PLC)	a control device, normally used in industrial control applications that employs the hardware architecture of a computer and programming language
Proportional Integral Derivative (PID)	proportional gain, integral action time and derivative action time. PID software, for example, compares an analog input value with a set-point and if there's a discrepancy outputs an appropriate analog or digital control value, according the PID calculations
range	the region between the limits within which a quantity is measured, received or transmitted; expressed by stating the lower and upper range values
ratio	the quotient of one quantity divided by another
remote	a device allowing the set point to be altered by a signal from a physical location away from the controller; necessary for cascade operation
repair	activities performed to correct faults; include cleaning, replacing, rebuilding
Safety Instrumented System (SIS)	equipment and networks dedicated to safety monitoring and protection of processes and equipment
sensing element	the element directly responsive to the value of the measured variable
signal	a form of energy that quantitatively represents a variable
strain gauge	a device that uses the change of electrical resistance of a wire under strain to measure applied force
Supervisory Control and Data Acquistion (SCADA)	a control package used to monitor and control a remote process; also includes hardware such as modems, telemetry, servers and control systems
telemetry	transmitting the readings of instruments to a remote location by means of wires, radio waves or other means

temperature bath	a volume of a substance held at constant temperature, so that an object placed in thermal contact with it is maintained at the same temperature
terminal	a peripheral device used by the operator to communicate with the computer or a wire connection
thermocouple	devices that convert heat energy into electrical energy consisting of two dissimilar metal strips fused together at one end
transducer	an element or device that receives energy in one form and converts to another form
transmitter	a transducer which responds to a measured variable by means of a sensing element, and converts it to a standardized transmission signal that is proportional to the measured variable
tuning	adjustment of parameters to optimize a particular process
Uninterruptible Power Supply (UPS)	used to keep critical equipment, including computers, running in the event of a power failure
Variable Frequency Drive (VFD) and Variable Speed Drive (VSD)	electronic equipment that allows an electric motor to be run at varying speeds
weir	an engineered obstruction placed in an open channel
wireless	noting or pertaining to any of various devices that are operated with or actuated by electromagnetic waves

APPENDIX C ACRONYMS

AC/DC	Alternating Current/Direct Current
A/D	Analog to Digital
CAD	Computer-Assisted Design
CCTV	Closed-Circuit TV
CEC	Canadian Electrical Code
CSA	Canadian Standards Association
D/A	Digital to Analog
DCS	Distributed Control System
DO	Dissolved Oxygen
DP	Differential Pressure
HART	Highway Addressable Remote Transducer
HMI	Human Machine Interface
I/O	Input/Output
I/P	Current to Pneumatic; Current to Pressure
ISA	Instrumentation, Systems and Automation Society or International Society of Automation
JSHA	Job Safety Hazard Assessment
LCD	Liquid Crystal Display
LOPA	Layers of Protection Analysis
MCC	Motor Control Center
MTU	Master Terminal Unit
OH&S	Occupational Health and Safety Act

OPC	Open Platform Communication
ORP	Oxidation Reduction Potential
P&ID	process and instrumentation diagram
PI	Proportional-Integral
PID	Proportional- Integral-Derivative
PLC	Programmable Logic Controller
PPE	Personal Protection Equipment
PSS	Process Safety Systems
RTD	Resistive Thermal Device
RTU	Remote Terminal Unit
SAC	Stand-Alone Controller
SAMA	Scientific Apparatus Makers Association
SCADA	Supervisory Control and Data Acquisition
SIF	Safety Instrumented Functions
SIL	Safety Integrity Level
SIS	Safety Instrumented System
TCP/IP	Transport Control Protocol/Internet Protocol
TDG	Transportation of Dangerous Goods
UPS	Uninterruptible Power Supply
UV/IR	Ultraviolet/Infrared
VFD	Variable Frequency Drive
VSD	Variable Speed Drive
WHMIS	Workplace Hazardous Materials Information System

APPENDIX D — BLOCK AND TASK WEIGHTING

BLOCK A COMMON OCCUPATIONAL SKILLS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	5	3	8	5	ND	5	10	5	5	5	NV	NV	NV	6%

Task 1 Performs safety-related functions.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	34	35	30	ND	40	40	20	20	20	NV	NV	NV	31%

Task 2 Organizes work.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	33	30	28	ND	40	20	35	40	35	NV	NV	NV	31%

Task 3 Performs routine trade activities.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	33	35	42	ND	20	40	45	40	45	NV	NV	NV	38%

BLOCK B PROCESS MEASURING AND INDICATING DEVICES

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	44	23	24	ND	28	30	20	30	25	NV	NV	NV	27%

Task 4 Installs and services pressure, temperature, level and flow devices.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	80	20	41	ND	50	40	25	40	40	NV	NV	NV	42%

Task 5 Installs and services motion, speed, position and vibration devices.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	4	20	14	ND	10	15	20	10	10	NV	NV	NV	13%

Task 6 Installs and services mass, density and consistency devices.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	7	20	21	ND	10	10	20	10	20	NV	NV	NV	15%

Task 7 Installs and services process analyzers.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	7	20	24	ND	20	25	20	20	20	NV	NV	NV	19%

Task 8 Installs and services multiple variable computing devices.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	2	20	0	ND	10	10	15	20	10	NV	NV	NV	11%

BLOCK C SAFETY AND SECURITY SYSTEMS AND DEVICES

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	10	3	12	7	ND	5	5	10	5	5	NV	NV	NV	7%

Task 9 Installs and services safety systems and devices.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	34	40	53	ND	50	60	50	50	30	NV	NV	NV	52%

Task 10 Installs and services facility security systems. (NOT COMMON CORE)

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	0	33	30	0	ND	0	10	0	0	30	NV	NV	NV	NCC*

Task 11 Installs and services safety instrumented systems (SISs).

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	33	30	47	ND	50	30	50	50	40	NV	NV	NV	48%

BLOCK D HYDRAULIC, PNEUMATIC AND ELECTRICAL SYSTEMS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	15	12	8	12	ND	6	5	14	5	10	NV	NV	NV	9%

Task 12 Installs and services control devices for hydraulic systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	25	25	17	ND	25	10	20	10	20	NV	NV	NV	19%

Task 13 Installs and services pneumatic equipment.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	25	30	35	ND	40	45	50	35	50	NV	NV	NV	39%

Task 14 Installs and services electrical and electronic equipment.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	50	45	48	ND	35	45	30	55	30	NV	NV	NV	42%

BLOCK E FINAL CONTROL DEVICES

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	16	20	21	ND	24	30	20	15	15	NV	NV	NV	20%

Task 15 Installs and services valves.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	25	31	25	33	ND	25	30	30	30	25	NV	NV	NV	28%

Task 16 Installs and services actuators.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	25	31	25	24	ND	35	30	30	30	25	NV	NV	NV	29%

Task 17 Installs and services positioners.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	25	31	25	28	ND	35	30	30	30	25	NV	NV	NV	28%

Task 18 Configures and services variable speed drives (VSDs).

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	25	7	25	15	ND	5	10	10	15	25	NV	NV	NV	15%

BLOCK F COMMUNICATION SYSTEMS AND DEVICES

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	10	7	11	6	ND	11	5	13	15	10	NV	NV	NV	10%

Task 19 Installs and services control network systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	14	40	39	ND	30	40	40	40	30	NV	NV	NV	35%

Task 20 Installs and services signal converters.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	72	40	40	ND	50	40	30	30	50	NV	NV	NV	42%

Task 21 Installs and services gateways, bridges and media converters.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	14	20	21	ND	20	20	30	30	20	NV	NV	NV	23%

BLOCK G CONTROL SYSTEMS AND PROCESS CONTROL

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	15	18	25	ND	21	15	18	25	30	NV	NV	NV	21%

Task 22 Establishes and optimizes process control strategies.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	13	13	32	ND	30	20	25	10	30	NV	NV	NV	22%

Task 23 Installs and services stand-alone controllers (SACs).

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	10	13	16	10	ND	15	5	15	15	14	NV	NV	NV	13%

Task 24 Installs and services programmable logic controllers (PLCs).

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	13	20	21	ND	20	30	20	30	17	NV	NV	NV	21%

Task 25 Installs and services distributed control systems (DCSs).

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	35	16	20	ND	20	30	20	30	17	NV	NV	NV	22%

Task 26 Installs and services human machine interfaces (HMIs).

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	13	19	9	ND	5	10	10	5	10	NV	NV	NV	11%

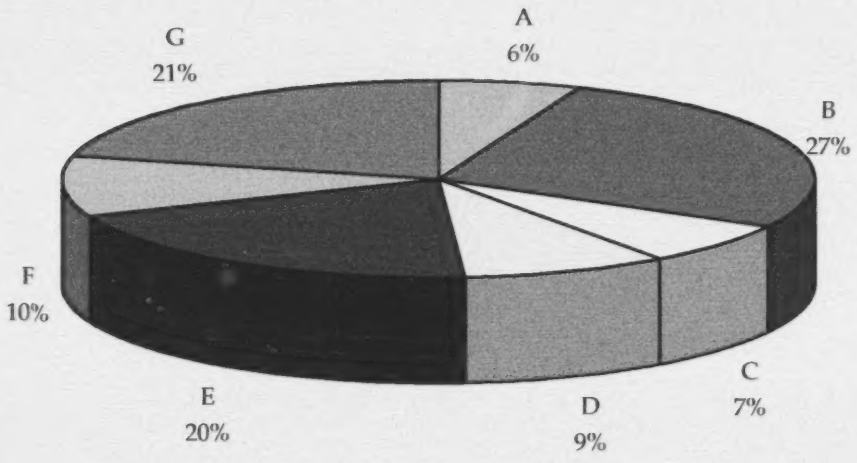
Task 27 Installs and services supervisory control and data acquisition (SCADA) systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	13	16	8	ND	10	5	10	10	12	NV	NV	NV	11%

* NOT COMMON CORE

APPENDIX E

PIE CHART*



TITLES OF BLOCKS

BLOCK A	Common Occupational Skills	BLOCK E	Final control devices
BLOCK B	Process measuring and indicating devices	BLOCK F	Communication systems and devices
BLOCK C	Safety and security systems and devices	BLOCK G	Control systems and process control
BLOCK D	Hydraulic, pneumatic and electrical systems		

*Average percentage of the total number of questions on an interprovincial examination, assigned to assess each block of the analysis, as derived from the collective input from workers within the occupation from all areas of Canada. Interprovincial examinations typically have from 100 to 150 multiple-choice questions.

APPENDIX F

TASK PROFILE CHART — Instrumentation and Control Technician

BLOCKS	TASKS	SUB-TASKS			
A – COMMON OCCUPATIONAL SKILLS	1. Performs safety-related functions.	1.01 Maintains safe work environment.	1.02 Uses personal protective equipment (PPE) and safety equipment.	1.03 Performs de-energizing, lock-out and tag-out procedures.	
	2. Organizes work.	2.01 Uses diagrams, drawings and schematics.	2.02 Plans tasks.		
	3. Performs routine trade activities.	3.01 Maintains calibration, configuration and test equipment.	3.02 Maintains tools.	3.03 Maintains documentation.	3.04 Operates material handling equipment.
B - PROCESS MEASURING AND INDICATING DEVICES	4. Installs and services pressure, temperature, level and flow devices.	4.01 Installs pressure, temperature, level and flow devices.	4.02 Maintains pressure, temperature, level and flow devices.	4.03 Diagnoses pressure, temperature, level and flow devices.	4.04 Repairs pressure, temperature, level and flow devices.
	5. Installs and services motion, speed, position and vibration devices.	5.01 Installs motion, speed, position and vibration devices.	5.02 Maintains motion, speed, position and vibration devices.	5.03 Diagnoses motion, speed, position and vibration devices.	5.04 Repairs motion, speed, position and vibration devices.
	6. Installs and services mass, density and consistency devices.	6.01 Installs mass, density and consistency devices.	6.02 Maintains mass, density and consistency devices.	6.03 Diagnoses mass, density and consistency devices.	6.04 Repairs mass, density and consistency devices.
	7. Installs and services process analyzers.	7.01 Installs process analyzers.	7.02 Maintains process analyzers.	7.03 Diagnoses process analyzers.	7.04 Repairs process analyzers.

BLOCKS	TASKS	SUB-TASKS				
	8. Installs and services multiple variable computing devices.	8.01 Installs multiple variable computing devices.	8.02 Maintains multiple variable computing devices.	8.03 Diagnoses multiple variable computing devices.	8.04 Repairs multiple variable computing devices.	
C- SAFETY AND SECURITY SYSTEMS AND DEVICES	9. Installs and services safety systems and devices.	9.01 Installs safety systems and devices.	9.02 Maintains safety systems and devices.	9.03 Diagnoses safety systems and devices.	9.04 Repairs safety systems and devices.	
	10. Installs and services facility security systems. (NOT COMMON CORE)	10.01 Installs facility security systems. (NOT COMMON CORE)	10.02 Maintains facility security systems. (NOT COMMON CORE)	10.03 Diagnoses facility security systems. (NOT COMMON CORE)	10.04 Repairs facility security systems. (NOT COMMON CORE)	
	11. Installs and services safety instrumented systems (SISs).	11.01 Installs SISs	11.02 Configures SISs.	11.03 Maintains SISs.	11.04 Diagnoses SISs.	11.05 Repairs SISs.
D - HYDRAULIC, PNEUMATIC AND ELECTRICAL SYSTEMS	12. Installs and services control devices for hydraulic systems.	12.01 Installs control devices for hydraulic systems.	12.02 Maintains control devices for hydraulic systems.	12.03 Diagnoses control devices and hydraulic systems.	12.04 Repairs control devices for hydraulic systems.	
	13. Installs and services pneumatic equipment.	13.01 Installs pneumatic equipment.	13.02 Maintains pneumatic equipment.	13.03 Diagnoses pneumatic equipment.	13.04 Repairs pneumatic equipment.	
	14. Installs and services electrical and electronic equipment.	14.01 Installs electrical and electronic equipment.	14.02 Maintains electrical and electronic equipment.	14.03 Diagnoses electrical and electronic equipment.	14.04 Repairs electrical and electronic equipment.	
E - FINAL CONTROL DEVICES	15. Installs and services valves.	15.01 Installs valves.	15.02 Maintains valves.	15.03 Diagnoses valves.	15.04 Repairs valves.	

BLOCKS	TASKS	SUB-TASKS			
	16. Installs and services actuators.	16.01 Installs actuators.	16.02 Maintains actuators.	16.03 Diagnoses actuators.	16.04 Repairs actuators.
	17. Installs and services positioners.	17.01 Installs positioners.	17.02 Maintains positioners.	17.03 Diagnoses positioners.	17.04 Repairs positioners.
	18. Configures and services variable speed drives (VSDs).	18.01 Configures VSDs.	18.02 Maintains VSDs.	18.03 Diagnoses VSDs.	18.04 Repairs VSDs.
F - COMMUNICATION SYSTEMS AND DEVICES	19. Installs and services control network systems.	19.01 Performs installation and configuration on control network systems.	19.02 Diagnoses control network systems.	19.03 Performs maintenance and repairs on control network systems.	
	20. Installs and services signal converters.	20.01 Performs installation and configuration of signal converters.	20.02 Diagnoses signal converters.	20.03 Performs maintenance and repairs on signal converters.	
	21 Installs and services gateways, bridges and media converters.	21.01 Performs installation and configuration of gateways, bridges and media converters.	21.02 Diagnoses gateways, bridges and media converters.	21.03 Performs maintenance and repairs on gateways, bridges and media converters.	
G - CONTROL SYSTEMS AND PROCESS CONTROL	22. Establishes and optimizes process control strategies.	22.01 Determines process control strategy.	22.02 Optimizes process control.		
	23. Installs and services stand-alone controllers (SACs).	23.01 Installs SACs.	23.02 Configures SACs.	23.03 Performs maintenance, diagnostics and repairs on SACs.	

BLOCKS	TASKS	SUB-TASKS		
	24. Installs and services programmable logic controllers (PLCs).	24.01 Installs PLCs.	24.02 Configures PLCs.	24.03 Performs maintenance, diagnosis and repairs on PLCs.
	25. Installs and services distributed control systems (DCSs).	25.01 Installs DCSs.	25.02 Configures DCSs.	25.03 Performs maintenance, diagnosis and repairs on DCSs.
	26. Installs and services human machine interfaces (HMIs).	26.01 Installs HMIs.	26.02 Configures HMIs.	26.03 Performs maintenance, diagnosis and repairs on HMIs.
	27. Installs and services supervisory control and data acquisition (SCADA) systems.	27.01 Installs SCADA systems.	27.02 Configures SCADA systems.	27.03 Performs maintenance, diagnosis and repairs on SCADA systems.